



Instruction Manual

VLT[®] Refrigeration Drive FC 103

1.1–90 kW





Danfoss A/S

6430 Nordborg
Denmark
CVR nr.: 20 16 57 15
Telephone: +45 7488 2222
Fax: +45 7449 0949

EU DECLARATION OF CONFORMITY

Danfoss A/S
Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter

Type designation(s): FC-103XYYYZZ*****

Character X: N or P

Character YYY: 1K1, 1K5, 2K2, 3K0, 3K7, 4K0, 5K5, 7K5, 11K, 15K, 18K, 22K, 30K, 37K, 45K, 55K, 75K, 90K, 110, 132, 160, 200, 250, 315, 400, 450, 500, 560, 630, 710, 800.

Character ZZ: T2, T4, T6, T7

* may be any number or letter indicating drive options which do not impact this DoC.

The meaning of the 39 characters in the type code string can be found in appendix 00729776.

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EN61800-5-1:2007 + A1:2017 Adjustable speed electrical power drive systems – Part 5-1:
Safety requirements – Electrical, thermal and energy.

EMC Directive 2014/30/EU

EN61800-3:2004 + A1:2012 Adjustable speed electrical power drive systems – Part 3: EMC
requirements and specific test methods.

RoHS Directive 2011/65/EU including amendment 2015/863.

EN63000:2018 Technical documentation for the assessment of electrical and
electronic products with respect to the restriction of
hazardous substances.

| | | | |
|-------------------------------------|---|-------------------------------------|--|
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| Graasten, DK | Signature: Name: Gert Kjær Title: Senior Director, GDE | Graasten, DK | Signature: Name: Michael Termansen Title: VP, PD Center Denmark |

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1 Introduction

1.1 Purpose of the Manual

This instruction manual provides information for safe installation and commissioning of the adjustable frequency drive.

This instruction manual is intended for use by qualified personnel.

Read and follow the instruction manual to use the adjustable frequency drive safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep this instruction manual available with the adjustable frequency drive at all times.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced adjustable frequency drive functions and programming.

- The *VLT® Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm for listings.

1.3 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version and the corresponding software version.

| Edition | Remarks | Software version |
|----------|-------------------|------------------|
| MG16E3xx | Replaces MG16E2xx | 1.21 |

Table 1.1 Document and Software Version

1.4 Product Overview

1.4.1 Intended Use

The adjustable frequency drive is an electronic motor controller intended for

- regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the adjustable frequency drive, the motor and equipment driven by the motor.
- system and motor status surveillance.

The adjustable frequency drive can also be used for motor protection.

Depending on configuration, the adjustable frequency drive can be used in standalone applications or form part of a larger appliance or installation.

The adjustable frequency drive is allowed for use in residential, industrial and commercial environments in accordance with local laws and standards.

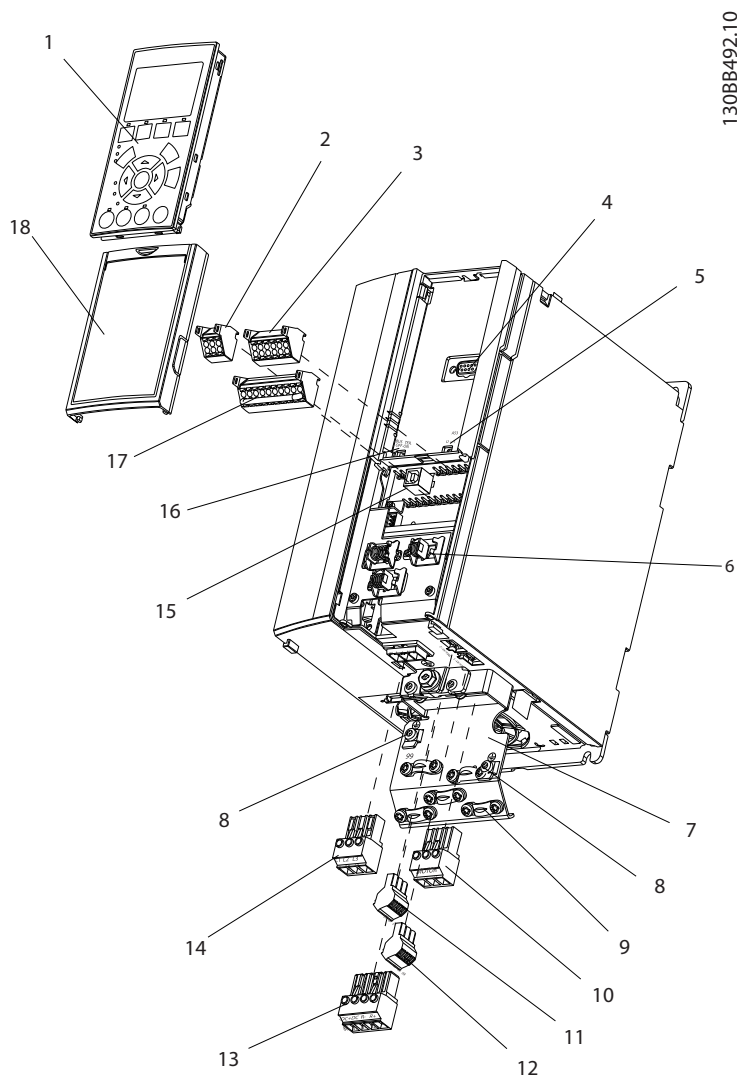
NOTICE!

In a residential environment, this product can cause radio interference, in which case supplementary mitigation measures can be required.

Foreseeable misuse

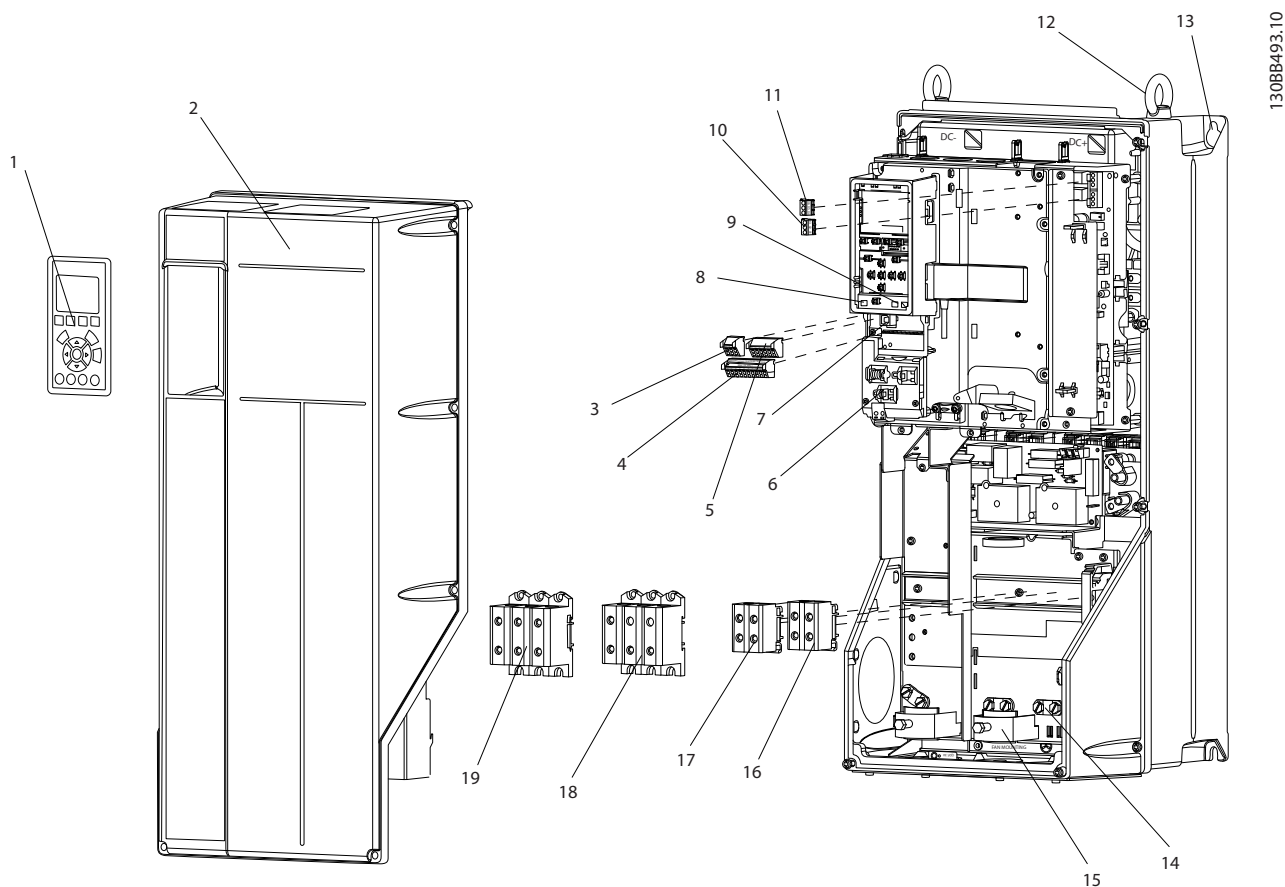
Do not use the adjustable frequency drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

1.4.2 Exploded Views



| | | | |
|---|--|----|--|
| 1 | Local control panel (LCP) | 10 | Motor output terminals 96 (U), 97 (V), 98 (W) |
| 2 | RS-485 serial bus connector (+68, -69) | 11 | Relay 2 (04, 05, 06) |
| 3 | Analog I/O connector | 12 | Relay 1 (01, 02, 03) |
| 4 | LCP input plug | 13 | - |
| 5 | Analog switches (A53), (A54) | 14 | Line power input terminals 91 (L1), 92 (L2), 93 (L3) |
| 6 | Cable shield connector | 15 | USB connector |
| 7 | Decoupling plate | 16 | Serial bus terminal switch |
| 8 | Grounding clamp (PE) | 17 | Digital I/O and 24 V power supply |
| 9 | Shielded cable grounding clamp and strain relief | 18 | Cover |

Figure 1.1 Exploded View Enclosure Type A, IP20



130BB493.10

| | | | |
|----|-----------------------------------|----|--|
| 1 | Local control panel (LCP) | 11 | Relay 2 (04, 05, 06) |
| 2 | Cover | 12 | Lifting ring |
| 3 | RS-485 serial bus connector | 13 | Mounting slot |
| 4 | Digital I/O and 24 V power supply | 14 | Grounding clamp (PE) |
| 5 | Analog I/O connector | 15 | Cable shield connector |
| 6 | Cable shield connector | 16 | - |
| 7 | USB connector | 17 | - |
| 8 | Serial bus terminal switch | 18 | Motor output terminals 96 (U), 97 (V), 98 (W) |
| 9 | Analog switches (A53), (A54) | 19 | Line power input terminals 91 (L1), 92 (L2), 93 (L3) |
| 10 | Relay 1 (01, 02, 03) | | |

Figure 1.2 Exploded View Enclosure Types B and C, IP55 and IP66

1.4.3 Block Diagram of the Adjustable Frequency Drive

Figure 1.3 is a block diagram of the internal components of the adjustable frequency drive. See Table 1.2 for their functions.

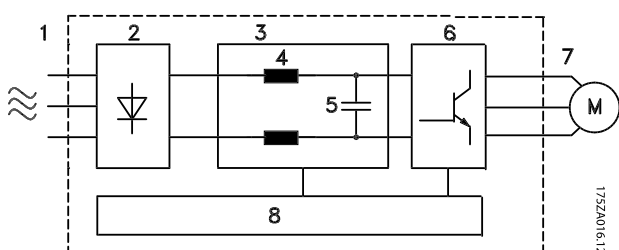


Figure 1.3 Adjustable Frequency Drive Block Diagram

| Area | Title | Functions |
|------|------------------|--|
| 1 | Line power input | <ul style="list-style-type: none"> 3-phase AC line power supply to the adjustable frequency drive |
| 2 | Rectifier | <ul style="list-style-type: none"> The rectifier bridge converts the AC input to DC current to supply inverter power |
| 3 | DC bus | <ul style="list-style-type: none"> Intermediate DC bus circuit handles the DC current |
| 4 | DC reactors | <ul style="list-style-type: none"> Filter the intermediate DC circuit voltage Provide line transient protection Reduce RMS current Raise the power factor reflected back to the line Reduce harmonics on the AC input |
| 5 | Capacitor bank | <ul style="list-style-type: none"> Stores the DC power Provides ride-through protection for short power losses |
| 6 | Inverter | <ul style="list-style-type: none"> Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor |
| 7 | Output to motor | <ul style="list-style-type: none"> Regulated 3-phase output power to the motor |

| Area | Title | Functions |
|------|-------------------|---|
| 8 | Control circuitry | <ul style="list-style-type: none"> Input power, internal processing, output, and motor current are monitored to provide efficient operation and control User interface and external commands are monitored and performed Status output and control can be provided |

Table 1.2 Legend to Figure 1.3

1.4.4 Enclosure Types and Power Ratings

For enclosure types and power ratings of the adjustable frequency drives, refer to chapter 8.9 Power Ratings, Weight and Dimensions.

1.5 Approvals and Certifications



Table 1.3 Approvals and Certifications

More approvals and certifications are available. Contact local Danfoss partner.

The adjustable frequency drive complies with UL508C thermal memory retention requirements. For more information, refer to the section Motor Thermal Protection in the Design Guide.

1.6 Disposal Instruction

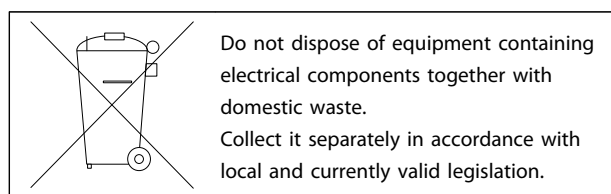


Table 1.4 Disposal Instruction

2

2 Safety

2.1 Safety Symbols

The following symbols are used in this document:

⚠ WARNING

Indicates a potentially hazardous situation which could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation which could result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that may result in damage to equipment or property.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation and maintenance are required for the trouble-free and safe operation of the adjustable frequency drive. Only qualified personnel is allowed to install or operate this equipment.

Qualified personnel is defined as trained staff, who are authorized to install, commission, and maintain equipment, systems and circuits in accordance with pertinent laws and regulations. Additionally, the personnel must be familiar with the instructions and safety measures described in this document.

2.3 Safety Precautions

⚠ WARNING

HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- Installation, start-up, and maintenance must be performed by qualified personnel only.

⚠ WARNING

UNINTENDED START

When the adjustable frequency drive is connected to AC line power, the motor may start at any time, causing risk of death, serious injury, equipment, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP, or after a cleared fault condition.

- Disconnect the adjustable frequency drive from line power whenever personal safety considerations make it necessary to avoid unintended motor start.
- Press [Off] on the LCP before programming parameters.
- The adjustable frequency drive, motor, and any driven equipment must be in operational readiness when the adjustable frequency drive is connected to AC line power.

⚠ WARNING

DISCHARGE TIME

The adjustable frequency drive contains DC link capacitors that can remain charged even when the adjustable frequency drive is not powered. Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

1. Stop motor.
2. Disconnect AC line power, permanent magnet type motors, and remote DC link power supplies, including battery backups, UPS, and DC link connections to other adjustable frequency drives.
3. Wait for the capacitors to discharge fully before performing any service or repair work. The duration of waiting time is specified in *Table 2.1*.

| Voltage [V] | Minimum waiting time (minutes) | |
|-------------|--------------------------------|--------------------------|
| | 4 | 15 |
| 200–240 | 1.5–5 hp [1.1–3.7 kW] | 7.5–60 hp [5.5–45 kW] |
| 380–500 | 1.5–10 hp [1.1–7.5 kW] | 15–125 hp [11–90 kW] |
| 525–600 | 1.5–10 hp [1.1–7.5 kW] | 15–125 hp [11–90 kW] |

High voltage may be present even when the warning LED indicator lights are off.

Table 2.1 Discharge Time

⚠ WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the adjustable frequency drive properly could result in death or serious injury.

- Ensure correct grounding of the equipment by a certified electrical installer.

⚠ WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.
- Ensure that electrical work conforms to national and local electrical codes.
- Follow the procedures in this manual.

⚠ CAUTION

WINDMILLING

Unintended rotation of permanent magnet motors causes risk of personal injury and equipment damage.

- Ensure that permanent magnet motors are blocked to prevent unintended rotation.

⚠ CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury when the adjustable frequency drive is not properly closed.

- Before applying power, ensure all safety covers are in place and securely fastened.

3 Mechanical Installation

3

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configuration.

- Make sure the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the adjustable frequency drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

NOTICE!

Do not remove the nameplate from the adjustable frequency drive (loss of warranty).

3.1.2 Storage

Ensure that requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

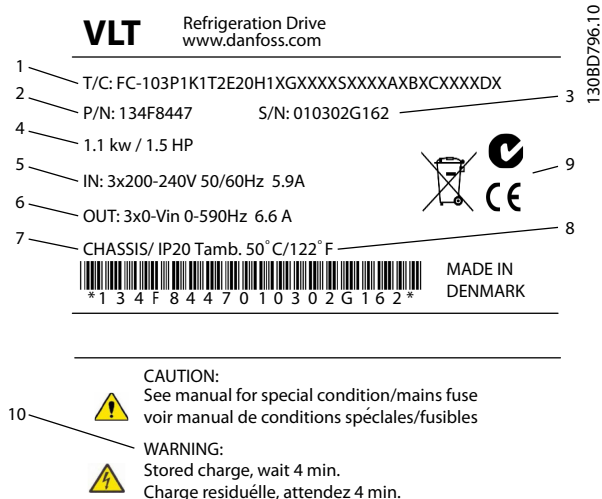
NOTICE!

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce lifetime of the adjustable frequency drive. Ensure that requirements for air humidity, temperature and altitude are met.

Vibration and Shock

The adjustable frequency drive complies with requirements for units mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.



| | |
|----|--|
| 1 | Type code |
| 2 | Order number |
| 3 | Serial number |
| 4 | Power rating |
| 5 | Input voltage, frequency and current (at low/high voltages) |
| 6 | Output voltage, frequency and current (at low/high voltages) |
| 7 | Enclosure type and IP rating |
| 8 | Maximum ambient temperature |
| 9 | Certifications |
| 10 | Discharge time (Warning) |

Figure 3.1 Product Nameplate (Example)

3.3 Mounting

NOTICE!

Improper mounting can result in overheating and reduced performance.

Cooling

- Ensure that top and bottom clearance for air cooling is provided. See Figure 3.2 for clearance requirements.

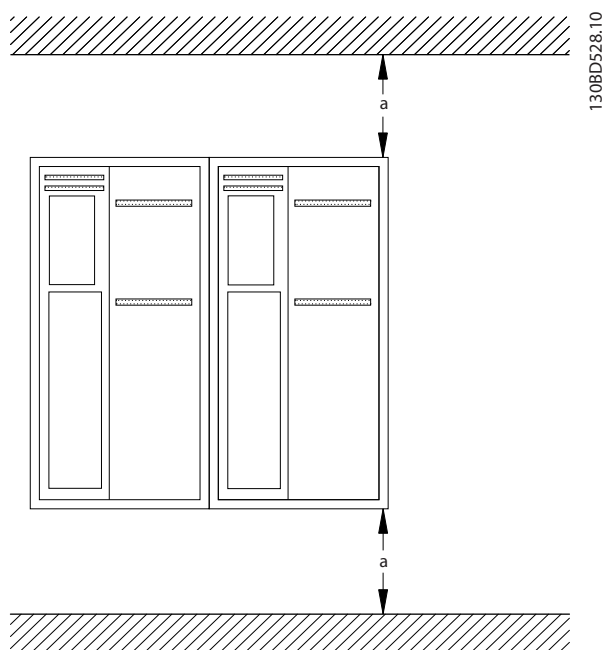


Figure 3.2 Top and Bottom Cooling Clearance

| Enclosure | A2-A5 | B1-B4 | C1, C3 | C2, C4 |
|--------------|------------|------------|------------|------------|
| a (ins [mm]) | 3.94 [100] | 7.87 [200] | 7.87 [200] | 8.86 [225] |

Table 3.1 Minimum Airflow Clearance Requirements

Lifting

- To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight and Dimensions*.
- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use hoist rings on the unit, when provided.

Mounting

1. Ensure that the strength of the mounting location supports the unit weight. The adjustable location frequency drive allows side-by-side installation.
2. Place the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mounting, when provided.

Mounting with backplate and railings

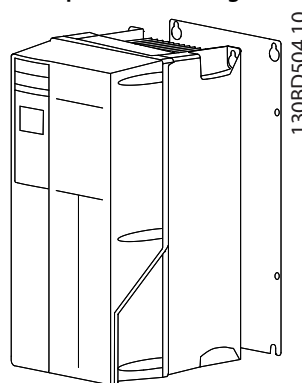


Figure 3.3 Proper Mounting with Backplate

NOTICE!

Backplate is required when mounted on railings.

NOTICE!

All A, B, and C enclosures allow side-by-side installation. Exception: if an IP21 kit is used, there has to be a clearance between the enclosures:

- For enclosures A2, A3, A4, B3, B4 and C3, the minimum clearance is 2 ins [50 mm].
- For enclosure C4, the minimum clearance is 3 ins [75 mm].

3

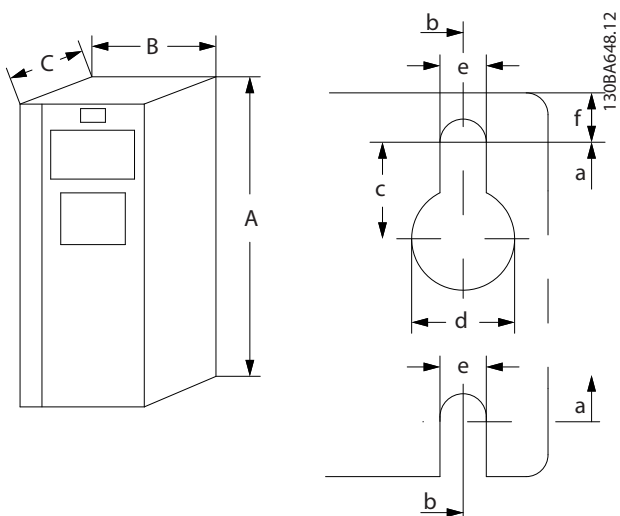


Figure 3.4 Top and Bottom Mounting Holes
(See chapter 8.9 Power Ratings, Weight and Dimensions)

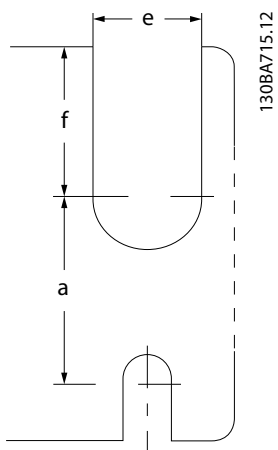


Figure 3.5 Top and Bottom Mounting Holes (B4, C3, C4)

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables or metal conduits could result in death or serious injury.

- run output motor cables separately, or
- use shielded cables or metal conduits

⚠ CAUTION

SHOCK HAZARD

The adjustable frequency drive can cause a DC current in the PE conductor. Failure to follow the recommendation below means the RCD may not provide the intended protection.

- When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.

NOTICE!

The adjustable frequency drive is supplied with Class 20 motor overload protection.

Overcurrent Protection

- Additional protective equipment such as short-circuit protection or motor thermal protection between adjustable frequency drive and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, fuses must be provided by the installer. See maximum fuse ratings in *chapter 8.8 Fuses and Circuit Breakers*.

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: minimum 167°F [75°C] rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Grounding

⚠ WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the adjustable frequency drive properly could result in death or serious injury.

- Ensure correct grounding of the equipment by a certified electrical installer.

For electrical safety

- Ground the adjustable frequency drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power and control wiring.
- Do not ground one adjustable frequency drive to another in a "daisy chain" fashion.
- Keep the ground wire connections as short as possible.
- Follow the motor manufacturer wiring requirements.
- Minimum cable cross-section: AWG 7 [10 mm²] (or two rated ground wires terminated separately).

For EMC-compliant installation

- Establish electrical contact between cable shield and adjustable frequency drive enclosure by using metal cable connectors or by using the clamps provided on the equipment (see *chapter 4.6 Motor Connection*).
- Use high-strand wire to reduce electrical interference.
- Do not use pigtails.

NOTICE!**POTENTIAL EQUALIZATION**

Risk of electrical interference, when the ground potential between the adjustable frequency drive and the system is different. Install equalizing cables between the system components. Recommended cable cross-section: AWG 6 [16 mm²].

4.4 Wiring Schematic

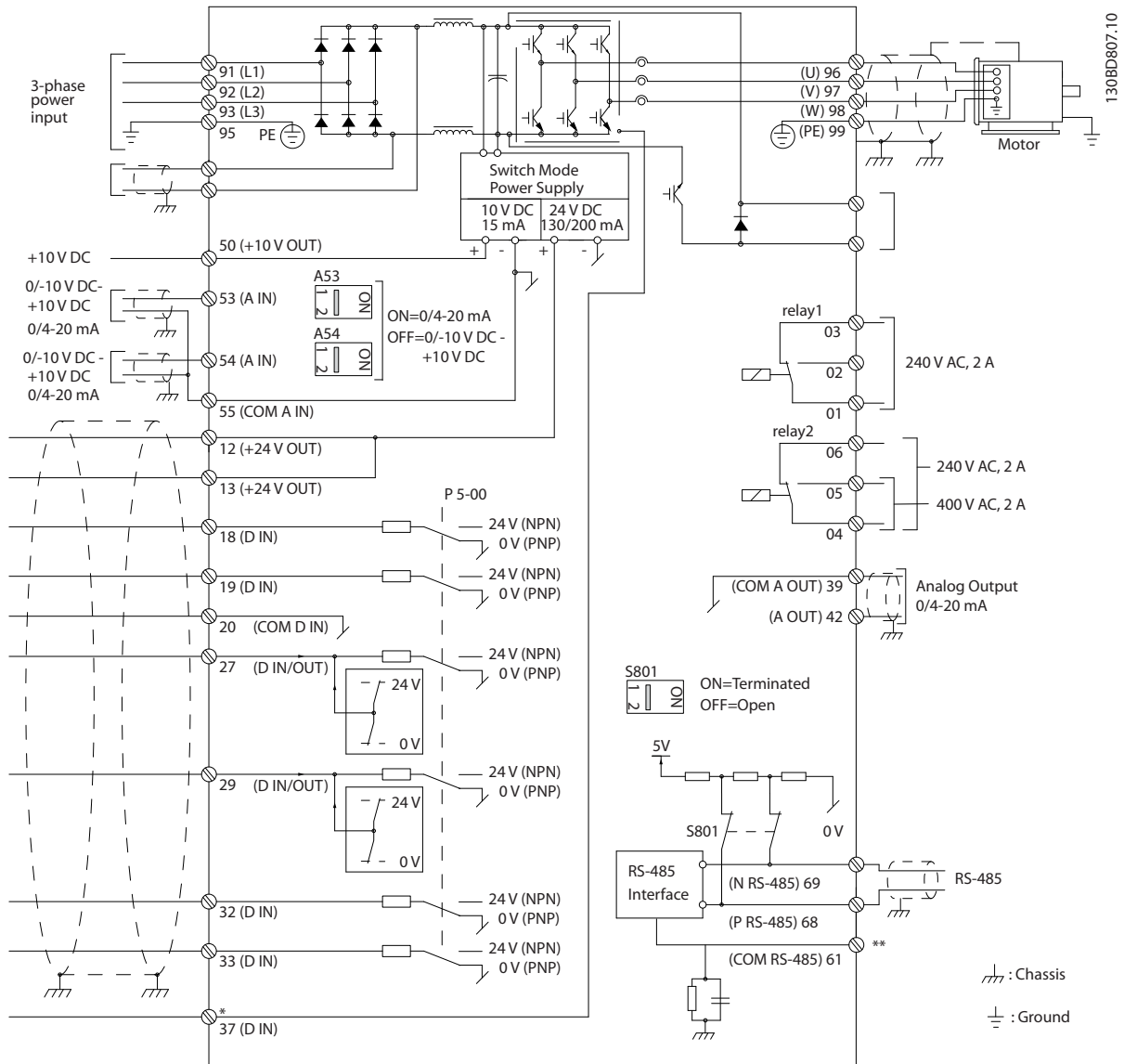
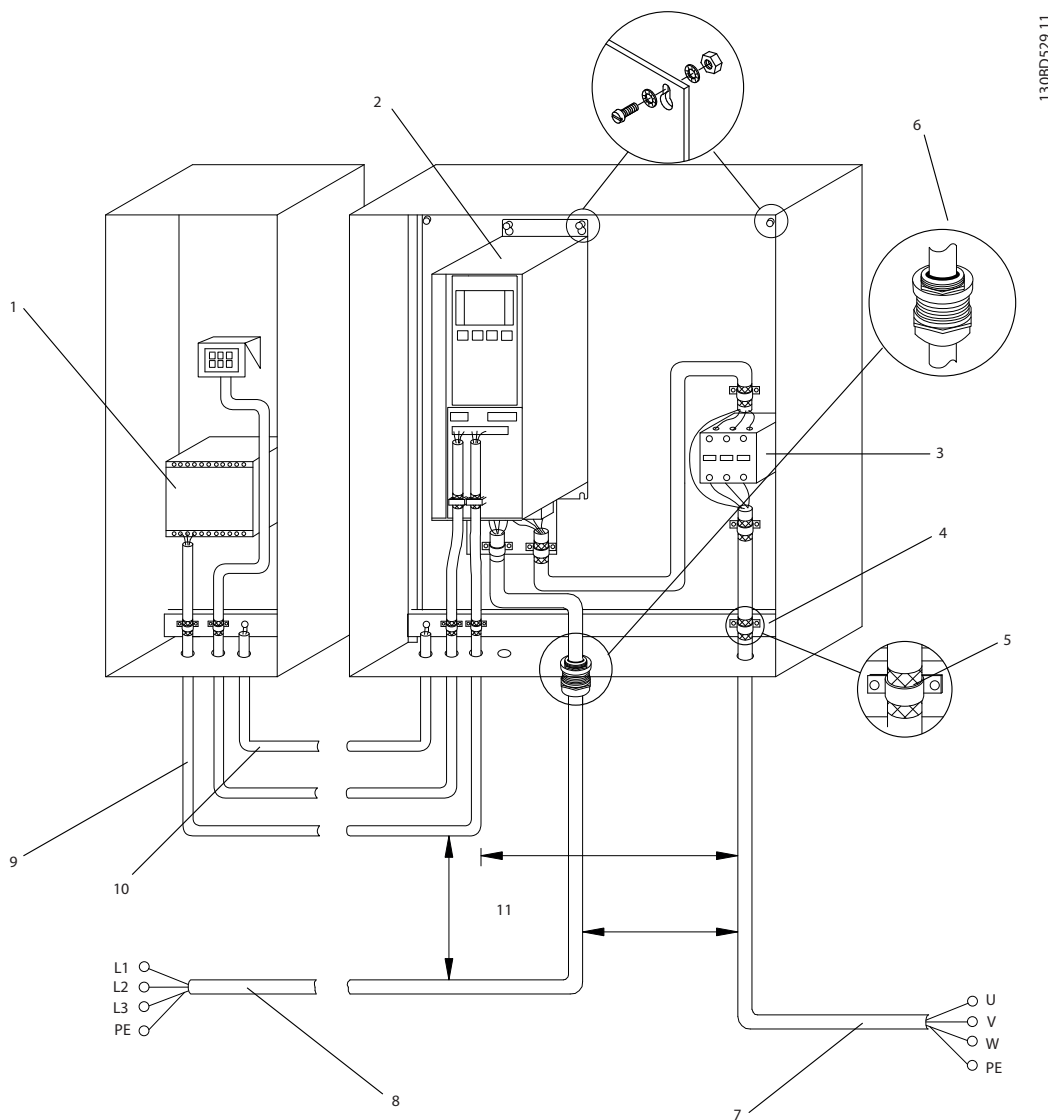


Figure 4.1 Basic Wiring Schematic

A=Analog, D=Digital

*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the *VLT® Adjustable Frequency Drives - Safe Torque Off Instruction Manual*.

**Do not connect cable shield.



1308D529.11

| | | | |
|---|-----------------------------|----|---|
| 1 | PLC | 6 | Cable connector |
| 2 | Adjustable frequency drive | 7 | Motor, 3-phase and PE |
| 3 | Output contactor | 8 | Line power, 3-phase and reinforced PE |
| 4 | Grounding rail (PE) | 9 | Control wiring |
| 5 | Cable insulation (stripped) | 10 | Equalizing min. 0.025 in ² [16 mm ²] |

Figure 4.2 EMC-compliant Electrical Connection

NOTICE

EMC INTERFERENCE

Run cables for input power, motor wiring and control wiring in three separate metallic conduits. Failure to isolate power, motor and control cables can result in unintended behavior or reduced performance. Minimum 7.9 in [200 mm] clearance between power, motor and control cables is required.

4.5 Access

- Remove cover with a screwdriver (See Figure 4.3) or by loosening attaching screws (See Figure 4.4).

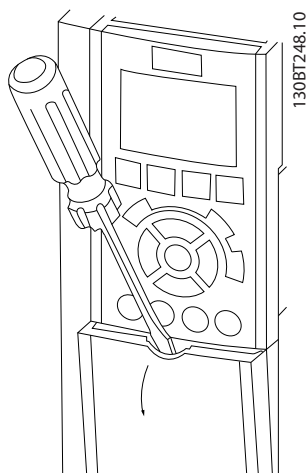


Figure 4.3 Access to Wiring for IP20 and IP21 Enclosures

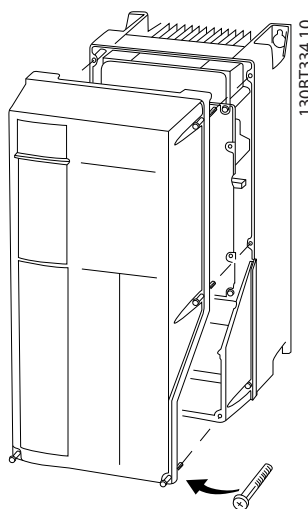


Figure 4.4 Access to Wiring for IP55 and IP66 Enclosures

See Table 4.1 before tightening the covers.

| Enclosure | IP55 | IP66 |
|---|------|------|
| A4/A5 | 2 | 2 |
| B1/B2 | 2.2 | 2.2 |
| C1/C2 | 2.2 | 2.2 |
| No screws to tighten for A2/A3/B3/B4/C3/C4. | | |

Table 4.1 Tightening Torques for Covers [Nm]

4.6 Motor Connection

WARNING

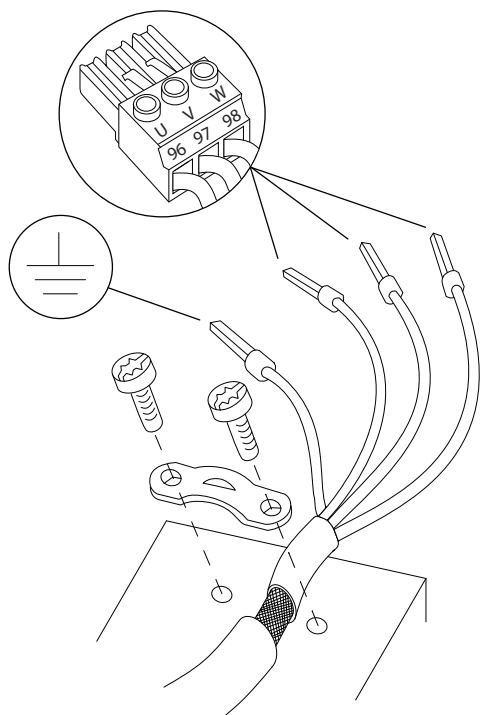
INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables or metal conduits could result in death or serious injury.

- run output motor cables separately, or
- use shielded cables or metal conduits
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow the motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (e.g., Dahlander motor or slip ring induction motor) between the adjustable frequency drive and the motor.

Procedure

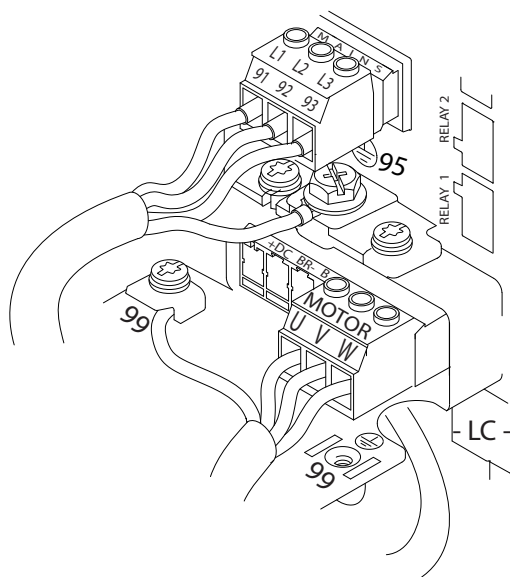
- Strip a section of the outer cable insulation.
- Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between cable shield and ground.
- Connect ground wire to the nearest grounding terminal in accordance with grounding instructions provided in *chapter 4.3 Grounding*, see *Figure 4.5*.
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Figure 4.5*.
- Tighten terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.



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Figure 4.5 Motor Connection

Figure 4.6 represents line power input, motor, and grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.



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Figure 4.6 Example of Motor, Line Power and Ground Wiring

4.7 AC Line Power Connection

- Size wiring based upon the input current of the adjustable frequency drive. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Figure 4.6*).
2. Depending on the configuration of the equipment, input power is connected to the line power input terminals or the input disconnect.
3. Ground the cable in accordance with grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated line power source (IT line power or floating delta) or TT/TN-S line power with a grounded leg (grounded delta), ensure that *14-50 RFI 1* is set to *[0] Off* to avoid damage to the intermediate circuit and to reduce ground capacity currents in accordance with IEC 61800-3.

4.8 Control Wiring

- Isolate control wiring from high power components in the adjustable frequency drive.
- When the adjustable frequency drive is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended.

4.8.1 Control Terminal Types

Figure 4.7 and Figure 4.8 show the removable adjustable frequency drive connectors. Terminal functions and default settings are summarized in Table 4.2.

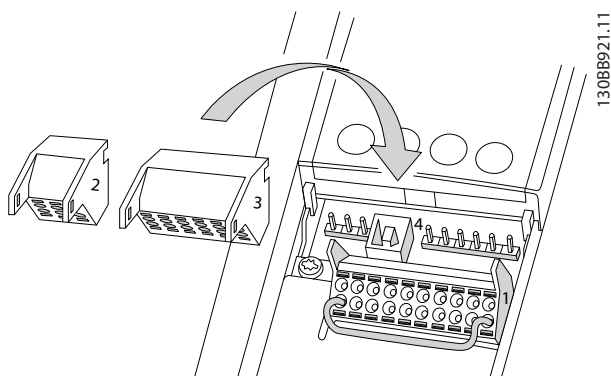


Figure 4.7 Control Terminal Locations

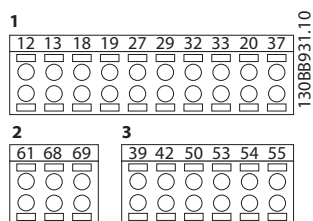


Figure 4.8 Terminal Numbers

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communication connection
- **Connector 3** provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output
- **Connector 4** is a USB port available for use with the MCT 10 Set-up Software

| Digital Inputs/Outputs | | | |
|------------------------|-----------|------------------------|--|
| Terminal | Parameter | Default setting | Description |
| 12, 13 | - | +24 V DC | 24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Usable for digital inputs and external transducers. |
| 18 | 5-10 | [8] Start | Digital inputs. |
| 19 | 5-11 | [10] Reversing | |
| 32 | 5-14 | [39] Day/Night Control | |
| 33 | 5-15 | [0] No operation | |
| 27 | 5-12 | [2] Coast inverse | Selectable for either digital input or output. Default setting is input. |
| 29 | 5-13 | [0] No operation | |
| 20 | - | | Common for digital inputs and 0 V potential for 24 V supply. |
| 37 | - | Safe Torque Off (STO) | (Optional) Safe input. Used for STO |
| Analog Inputs/Outputs | | | |
| 39 | - | | Common for analog output. |
| 42 | 6-50 | [100] Output frequency | Programmable analog output. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω. |
| 50 | - | +10 V DC | 10 V DC analog supply voltage. 15 mA maximum commonly used for potentiometer or thermistor. |
| 53 | 6-1* | Reference | Analog input. |
| 54 | 6-2* | Feedback | Selectable for voltage or current. Switches A53 and A54 select mA or V. |
| 55 | - | | Common for analog input. |
| Serial Communication | | | |
| 61 | - | | Integrated RC filter for cable shield. ONLY for connecting the shield when experiencing EMC problems. |

| Digital Inputs/Outputs | | | |
|------------------------|-----------|-----------------|---|
| Terminal | Parameter | Default setting | Description |
| 68 (+) | 8-3* | | RS-485 Interface. A control card switch is provided for termination resistance. |
| 69 (-) | 8-3* | | |
| Relays | | | |
| 01, 02, 03 | 5-40 | [2] Drive ready | Form C relay output. |
| 04, 05, 06 | 5-40 | [5] Running | Usable for AC or DC voltage and resistive or inductive loads. |

Table 4.2 Terminal Description

Additional terminals:

- two form C relay outputs. Location of the outputs depends on adjustable frequency drive configuration.
- Terminals located on built-in optional equipment. See the manual provided with the equipment option.

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the adjustable frequency drive for ease of installation, as shown in *Figure 4.7*.

NOTICE!

Keep control wires as short as possible and separate from high power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

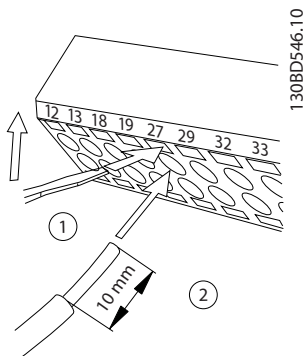


Figure 4.9 Connecting Control Wires

2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the adjustable frequency drive to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive an 24 V DC external interlock command. In many applications, the user wires an external interlock device to terminal 27.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads AUTO REMOTE COAST, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

NOTICE!

The adjustable frequency drive cannot operate without a signal on terminal 27 unless terminal 27 is re-programmed.

4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter settings:

- Terminal 53: speed reference signal in open-loop (see 16-61 Terminal 53 Switch Setting).
- Terminal 54: feedback signal in closed-loop (see 16-63 Terminal 54 Switch Setting).

NOTICE!

Disconnect power to the adjustable frequency drive before changing switch positions.

1. Remove the local control panel (see Figure 4.10).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

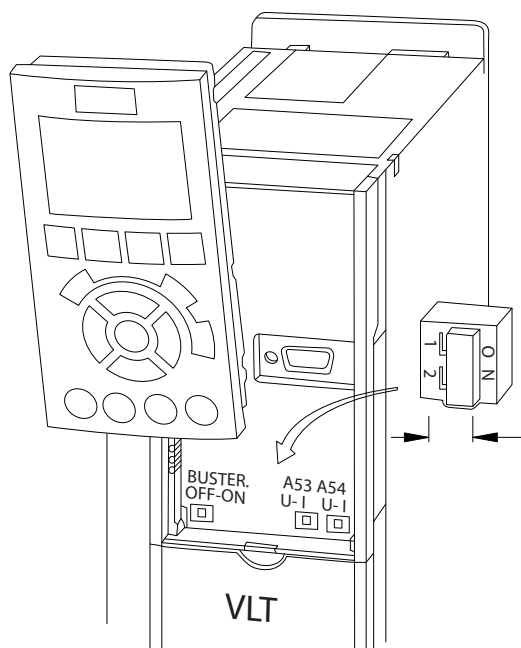


Figure 4.10 Location of Terminals 53 and 54 Switches

4.8.5 Safe Torque Off (STO)

To run Safe Torque Off, additional wiring for the adjustable frequency drive is required, refer to *Safe Torque Off Instruction Manual for Danfoss VLT® Adjustable Frequency Drives* for further information.

4.8.6 RS-485 Serial Communication

Connect RS-485 serial communication wiring to terminals (+)68 and (-)69.

- Use shielded serial communication cable (recommended)
- See chapter 4.3 Grounding for proper grounding.

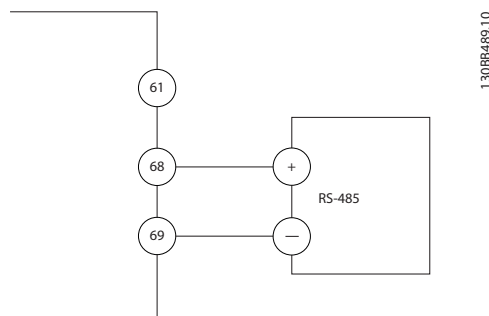


Figure 4.11 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following:

1. Protocol type in 8-30 Protocol.
 2. Adjustable frequency drive address in 8-31 Address.
 3. Baud rate in 8-32 Baud Rate.
- Communication protocols are internal to the adjustable frequency drive.
 - [0] FC Profile
 - [1] FC/MC Profile
 - [2] Modbus RTU
 - [3] Metasys N2
 - [9] FC Option
 - Functions can be programmed remotely using the protocol software and RS-485 connection or in parameter group 8-** Communications and Options.
 - Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications along with making additional protocol-specific parameters available.
 - Option cards which can be installed in the adjustable frequency drive are available to provide additional communication protocols. See the option-card documentation for installation and operation instructions.

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.3*. Check and mark the items when completed.

| Inspect for | Description | <input checked="" type="checkbox"/> |
|-------------------------------|---|-------------------------------------|
| Auxiliary equipment | <ul style="list-style-type: none"> Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the adjustable frequency drive or output side to the motor. Ensure that they are ready for full-speed operation Check function and installation of any sensors used for feedback to the adjustable frequency drive. Remove any power factor correction caps on motor(s) Adjust any power factor correction caps on the line power side and ensure that they are dampened | |
| Cable routing | <ul style="list-style-type: none"> Ensure that motor wiring and control wiring are separated or shielded or in three separate metallic conduits for high-frequency interference isolation | |
| Control wiring | <ul style="list-style-type: none"> Check for broken or damaged wires and loose connections. Check that control wiring is isolated from power and motor wiring for noise immunity. Check the voltage source of the signals, if necessary. The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly. | |
| Cooling clearance | <ul style="list-style-type: none"> Measure that top and bottom clearance is adequate to ensure proper air flow for cooling, see <i>chapter 3.3 Mounting</i> | |
| Ambient conditions | <ul style="list-style-type: none"> Check that requirements for ambient conditions are met | |
| Fusing and circuit breakers | <ul style="list-style-type: none"> Check for proper fusing or circuit breakers. Check that all fuses are inserted firmly and are in operational condition and that all circuit breakers are in the open position | |
| Grounding | <ul style="list-style-type: none"> Check for sufficient ground connections that are tight and free of oxidation Grounding to conduit or mounting the back panel to a metal surface is not a suitable grounding | |
| Input and output power wiring | <ul style="list-style-type: none"> Check for loose connections. Check that motor and line power are in separate conduits or separated shielded cables. | |
| Panel interior | <ul style="list-style-type: none"> Make sure that the unit interior is free of dirt, metal chips, moisture, and corrosion. Check that the unit is mounted on an unpainted, metal surface. | |
| Switches | <ul style="list-style-type: none"> Ensure that all switch and disconnect settings are in the proper positions. | |
| Vibration | <ul style="list-style-type: none"> Check that the unit is mounted solidly or that shock mounts are used, as necessary. Check for an unusual amount of vibration. | |

Table 4.3 Installation Check List

CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury when the adjustable frequency drive is not properly closed.

- Before applying power, ensure all safety covers are in place and securely fastened.

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠ WARNING

HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line input power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- Installation, start-up, and maintenance must be performed by qualified personnel only.

Before applying power:

1. Close cover properly.
2. Check that all cable connectors are firmly tightened.
3. Ensure that input power to the unit is OFF and locked out. Do not rely on the adjustable frequency drive disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
6. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
7. Check for proper grounding of the adjustable frequency drive as well as the motor.
8. Inspect the adjustable frequency drive for loose connections on terminals.
9. Confirm that the supply voltage matches voltage of adjustable frequency drive and motor.

5.2 Applying Power

⚠ WARNING

UNINTENDED START

When the adjustable frequency drive is connected to AC line power, the motor may start at any time, causing risk of death, serious injury, equipment, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP, or after a cleared fault condition.

- Disconnect the adjustable frequency drive from line power whenever personal safety considerations make it necessary to avoid unintended motor start.
- Press [Off] on the LCP before programming parameters.
- The adjustable frequency drive, motor, and any driven equipment must be in operational readiness when the adjustable frequency drive is connected to AC line power.

Apply power to the adjustable frequency drive using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that optional equipment wiring, if present, matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors must be closed or cover mounted.
4. Apply power to the unit. DO NOT start the adjustable frequency drive now. For units with a disconnect switch, turn to the ON position to apply power to the adjustable frequency drive.

NOTICE!

When the status line at the bottom of the LCP reads **AUTO REMOTE COASTING** or *Alarm 60 External Interlock* is displayed, this message indicates that the unit is ready to operate but is missing an input signal on, for example, terminal 27. See *chapter 4.8.3 Enabling Motor Operation (Terminal 27)* for details.

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit.

The LCP has several user functions:

- Start, stop, and control speed when in local control
- Display operational data, status, warnings and cautions
- Programming adjustable frequency drive functions
- Manually reset the adjustable frequency drive after a fault when auto-reset is inactive

NOTICE!

For commissioning via PC, install MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, order number 130B1000). For more information and downloads, see www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm.

5.3.2 LCP Layout

The LCP is divided into four functional groups (see Figure 5.1).

- A. Display area
- B. Display menu keys
- C. Navigation keys and LEDs
- D. Operation keys and reset

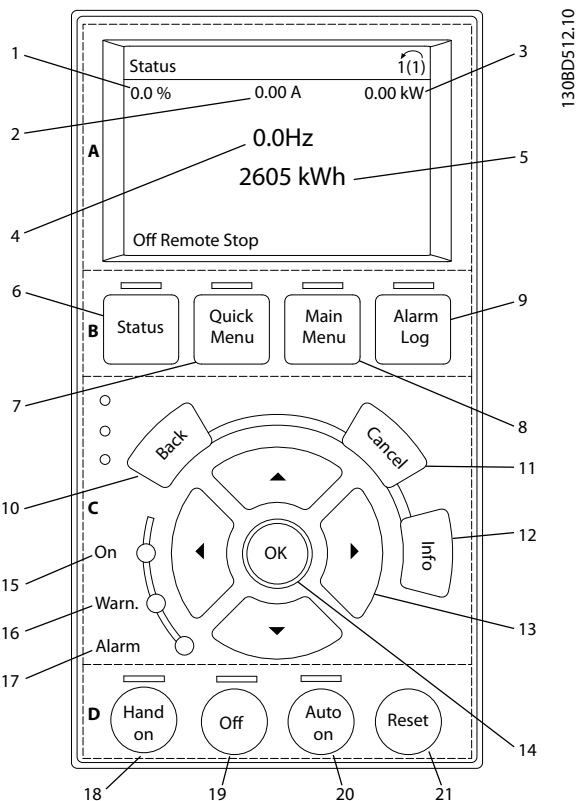


Figure 5.1 Local Control Panel (LCP)

A. Display Area

The display area is activated when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customized for user application. Select options in the Quick Menu Q3-13 Display Settings.

| Callout | Display | Parameter number | Default setting |
|---------|---------|------------------|-----------------|
| 1 | 1.1 | 0-20 | Reference % |
| 2 | 1.2 | 0-21 | Motor current |
| 3 | 1.3 | 0-22 | Power [kW] |
| 4 | 2 | 0-23 | Frequency |
| 5 | 3 | 0-24 | kWh counter |

Table 5.1 Legend to Figure 5.1, Display Area

B. Display Menu Keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

| Callout | Key | Function |
|---------|------------|---|
| 6 | Status | Shows operational information. |
| 7 | Quick Menu | Allows access to programming parameters for initial set-up instructions and many detailed application instructions. |
| 8 | Main Menu | Allows access to all programming parameters. |
| 9 | Alarm Log | Displays a list of current warnings, the last ten alarms, and the maintenance log. |

Table 5.2 Legend to Figure 5.1, Display Menu Keys

C. Navigation Keys and Indicator Lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. There are also three adjustable frequency drive status indicator lights in this area.

| Callout | Key | Function |
|---------|-----------------|---|
| 10 | Back | Reverts to the previous step or list in the menu structure. |
| 11 | Cancel | Cancels the last change or command as long as the display mode has not changed. |
| 12 | Indo | Press for a definition of the function being displayed. |
| 13 | Navigation keys | Press to move between items in the menu. |
| 14 | OK | Press to access parameter groups or to enable a choice. |

Table 5.3 Legend to Figure 5.1, Navigation Keys

| Callout | Indicator | Light | Function |
|---------|-----------|--------|--|
| 15 | ON | Green | The ON light activates when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V supply. |
| 16 | WARN | Yellow | When warning conditions are met, the yellow WARN light comes on and text appears in the display area identifying the problem. |
| 17 | ALARM | Red | A fault condition causes the red alarm light to flash and an alarm text is displayed. |

Table 5.4 Legend to Figure 5.1, Indicator Lights (LEDs)

D. Operation Keys and Reset

Operation keys are located at the bottom of the LCP.

| Callout | Key | Function |
|---------|---------|--|
| 18 | Hand On | Starts the adjustable frequency drive in local control. <ul style="list-style-type: none"> An external stop signal by control input or serial communication overrides the local hand on |
| 19 | Off | Stops the motor but does not remove power to the adjustable frequency drive. |
| 20 | Auto On | Puts the system in remote operational mode. <ul style="list-style-type: none"> Responds to an external start command by control terminals or serial communication |
| 21 | Reset | Resets the adjustable frequency drive manually after a fault has been cleared. |

Table 5.5 Legend to Figure 5.1, Operation Keys and Reset

NOTICE!

The display contrast can be adjusted by pressing [Status] and [▲]/[▼] keys.

5.3.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in *chapter 9.2 Parameter Menu Structure*.

Programming data are stored internally in the adjustable frequency drive.

- For backup, upload data into the LCP memory
- To download data to another adjustable frequency drive, connect the LCP to that unit and download the stored settings
- Restoring factory default settings does not change data stored in the LCP memory

5.3.4 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to [Main Menu] *0-50 LCP Copy* and press [OK].
3. Select [1] *All to LCP* to upload data to LCP or select [2] *All from LCP* to download data from the LCP.
4. Press [OK]. A progress bar shows the uploading or downloading process.
5. Press [Hand On] or [Auto On] to return to normal operation.

5.3.5 Changing Parameter Settings

Parameter settings can be accessed and changed from the [Quick Menu] or from the [Main Menu]. The [Quick Menu] only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
3. Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
4. Press [▲] [▼] to change the value of a parameter setting.

5. Press [◀] [▶] to shift digit when a decimal parameter is in the editing state.
6. Press [OK] to accept the change.
7. Press either [Back] twice to enter Status, or press [Main Menu] once to enter Main Menu.

View changes

Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list shows only parameters which have been changed in the current edit set-up.
- Parameters which have been reset to default values are not listed.
- The message *Empty* indicates that no parameters have been changed.

5.3.6 Restoring Default Settings

NOTICE!

Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a backup, upload data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the adjustable frequency drive. Initialization is carried out through *14-22 Operation Mode* (recommended) or manually.

- Initialization using *14-22 Operation Mode* does not reset adjustable frequency drive settings such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

Recommended initialization procedure, via 14-22 Operation Mode

1. Press [Main Menu] twice to access parameters.
2. Scroll to *14-22 Operation Mode* and press [OK].
3. Scroll to *Initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. This may take slightly longer than normal.

6. Alarm 80 is displayed.
7. Press [Reset] to return to operation mode.

Manual initialization procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. This may take slightly longer than normal.

Manual initialization does not reset the following adjustable frequency drive information:

- 15-00 Operating hours
- 15-03 Power-ups
- 15-04 Over Temps
- 15-05 Over Volts

5.4 Basic Programming

5.4.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- At first power-up or after initialization of the adjustable frequency drive, SmartStart starts automatically.
- Follow on-screen instructions to complete commissioning of the adjustable frequency drive. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the *Programming Guide*.

NOTICE!

Motor data are required for the SmartStart set-up. The required data are normally available on the motor nameplate.

5.4.2 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and checkout purposes. Application settings may vary.

Enter data with power ON, but before operating the adjustable frequency drive.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to parameter group *0-** Operation/Display* and press [OK].

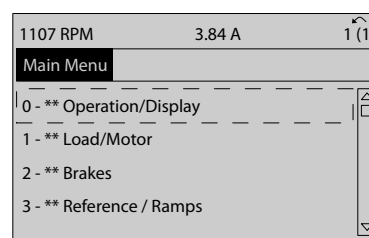


Figure 5.2 Main Menu

- Press navigation keys to scroll to parameter group *0-0* Basic Settings* and press [OK].

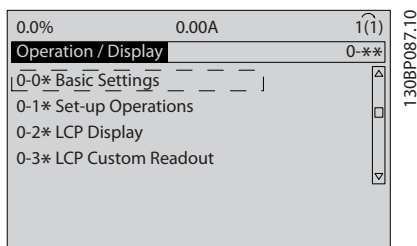


Figure 5.3 Operation/Display

- Press navigation keys to scroll to *0-03 Regional Settings* and press [OK].

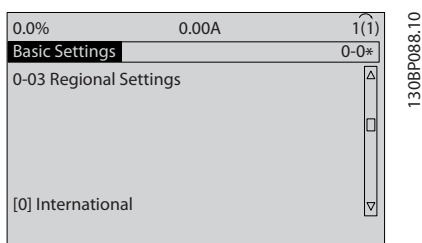


Figure 5.4 Basic Settings

- Press navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters).
- Press [Main Menu] on the LCP.
- Press the navigation keys to scroll to *0-01 Language*.
- Select language and press [OK].
- If a jumper wire is in place between control terminals 12 and 27, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *No Operation* in *5-12 Terminal 27 Digital Input*. For adjustable frequency drives with an optional bypass, no jumper wire is required between control terminals 12 and 27.
- 3-02 Minimum Reference*
- 3-03 Maximum Reference*
- 3-41 Ramp 1 Ramp-up Time*
- 3-42 Ramp 1 Ramp-down Time*
- 3-13 Reference Site*. Linked to Hand/Auto Local Remote.

5.4.3 Asynchronous Motor Set-up

Enter the motor data in parameter *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]* to *1-25 Motor Nominal Speed*. The information can be found on the motor nameplate.

- 1-20 Motor Power [kW]* or *1-21 Motor Power [HP]*
- 1-22 Motor Voltage*
- 1-23 Motor Frequency*
- 1-24 Motor Current*
- 1-25 Motor Nominal Speed*

5.4.4 PM Motor Set-up in VVC^{plus}

NOTICE!

Only use permanent magnet (PM) motor with fans and pumps.

Initial Programming Steps

- Activate PM motor operation *1-10 Motor Construction*, select (1) *PM, non-salient SPM*
- Set *0-02 Motor Speed Unit* to *[0] RPM*

Programming motor data

After selecting PM motor in *1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Addl. Motor Data* and *1-4** are active. The necessary data can be found on the motor nameplate and in the motor data sheet.

Program the following parameters in the listed order

- 1-24 Motor Current*
- 1-26 Motor Cont. Rated Torque*
- 1-25 Motor Nominal Speed*
- 1-39 Motor Poles*
- 1-30 Stator Resistance (Rs)*
Enter line to common stator winding resistance (Rs). If only line-line data are available, divide the line-line value by 2 to achieve the line to common (starpoint) value.
- 1-37 d-axis Inductance (Ld)*
Enter line to common direct axis inductance of the PM motor.
If only line-line data are available, divide the line-line value by 2 to achieve the line-common (starpoint) value.

- 1-40 Back EMF at 1000 RPM*

Enter line-to-line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1,000 RPM measured between two lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is, e.g., 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *1-40 Back EMF at 1000 RPM*.

Test Motor Operation

- Start the motor at low speed (100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.
- Check if start function in *1-70 PM Start Mode* fits the application requirements.

Rotor detection

This function is the recommended choice for applications where the motor starts from standstill, e.g., pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

Parking

This function is the recommended choice for applications where the motor is rotating at slow speed, e.g., windmilling in fan applications. *2-06 Parking Current* and *2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC^{plus} PM settings. Recommendations for different applications can be seen in *Table 5.6*.

| Application | Settings |
|---|---|
| Low inertia applications $I_{Load}/I_{Motor} < 5$ | <i>1-17 Voltage Filter Time Const.</i> to be increased by factor 5 to 10 <i>1-14 Damping Gain</i> should be reduced <i>1-66 Min. Current at Low Speed</i> should be reduced (<100%) |
| Low inertia applications $50 > I_{Load}/I_{Motor} > 5$ | Keep calculated values |
| High inertia applications $I_{Load}/I_{Motor} > 50$ | <i>1-14 Damping Gain</i> , <i>1-15 Low Speed Filter Time Const.</i> and <i>1-16 High Speed Filter Time Const.</i> should be increased |
| High load at low speed <30% (rated speed) | <i>1-17 Voltage Filter Time Const.</i> should be increased <i>1-66 Min. Current at Low Speed</i> should be increased (>100% for a prolonged time can overheat the motor) |

Table 5.6 Recommendations for Different Applications

If the motor starts oscillating at a certain speed, increase *1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

Starting torque can be adjusted in *1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.5 Automatic Energy Optimization (AEO)

NOTICE!

AEO is not relevant for permanent magnet motors.

Automatic Energy Optimization (AEO) is a procedure that minimizes voltage to the motor, reducing energy consumption, heat, and noise.

To activate AEO, set parameter *1-03 Torque Characteristics* to [2] *Auto Energy Optim. CT* or [3] *Auto Energy Optim. VT*.

5.4.6 Automatic Motor Adaptation (AMA)

NOTICE!

AMA is not relevant for PM motors.

Automatic motor adaptation (AMA) is a procedure that optimizes compatibility between the adjustable frequency drive and the motor.

- The adjustable frequency drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters 1-20 to 1-25.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select [2] *Enable reduced AMA*.
- If an output filter is connected to the motor, select *Enable reduced AMA*.
- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.
- Run this procedure on a cold motor for best results.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group 1-** *Load and Motor* and press [OK].
3. Scroll to parameter group 1-2* *Motor Data* and press [OK].
4. Scroll to 1-29 *Automatic Motor Adaptation (AMA)* and press [OK].
5. Select [1] *Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicate when it is complete.

5.5 Checking Motor Rotation

NOTICE!

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the adjustable frequency drive, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in 4-12 *Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to 1-28 *Motor Rotation Check* and press [OK].
3. Scroll to [1] *Enable*.

The following text appears: *Note! Motor may run in wrong direction.*

4. Press [OK].
5. Follow the on-screen instructions.

NOTICE!

To change the direction of rotation, remove power to the adjustable frequency drive and wait for power to discharge. Reverse the connection of any two of the three motor wires on the motor or adjustable frequency drive side of the connection.

5.6 Local Control Test

1. Press [Hand On] to provide a local start command to the adjustable frequency drive.
2. Accelerate the adjustable frequency drive by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

In the event of acceleration or deceleration problems, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* and *chapter 7.4 List of Warnings and Alarms* for resetting the adjustable frequency drive after a trip.

5.7 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check sound and vibration level of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see or *chapter 7.4 List of Warnings and Alarms*.

6 Application Set-up Examples

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these are also shown.

NOTICE!

When the optional Safe Torque Off feature is used, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the adjustable frequency drive to operate when using factory default programming values.

6

6.1 Application Examples

6.1.1 Compressor

The SmartStart guides the user through the set-up of a refrigeration compressor asking for input data about the compressor and the refrigeration system on which the adjustable frequency drive will be running. All terminology and units used within the SmartStart are common refrigeration type and set up is thus completed in 10-15 easy steps using just two keys of the LCP.

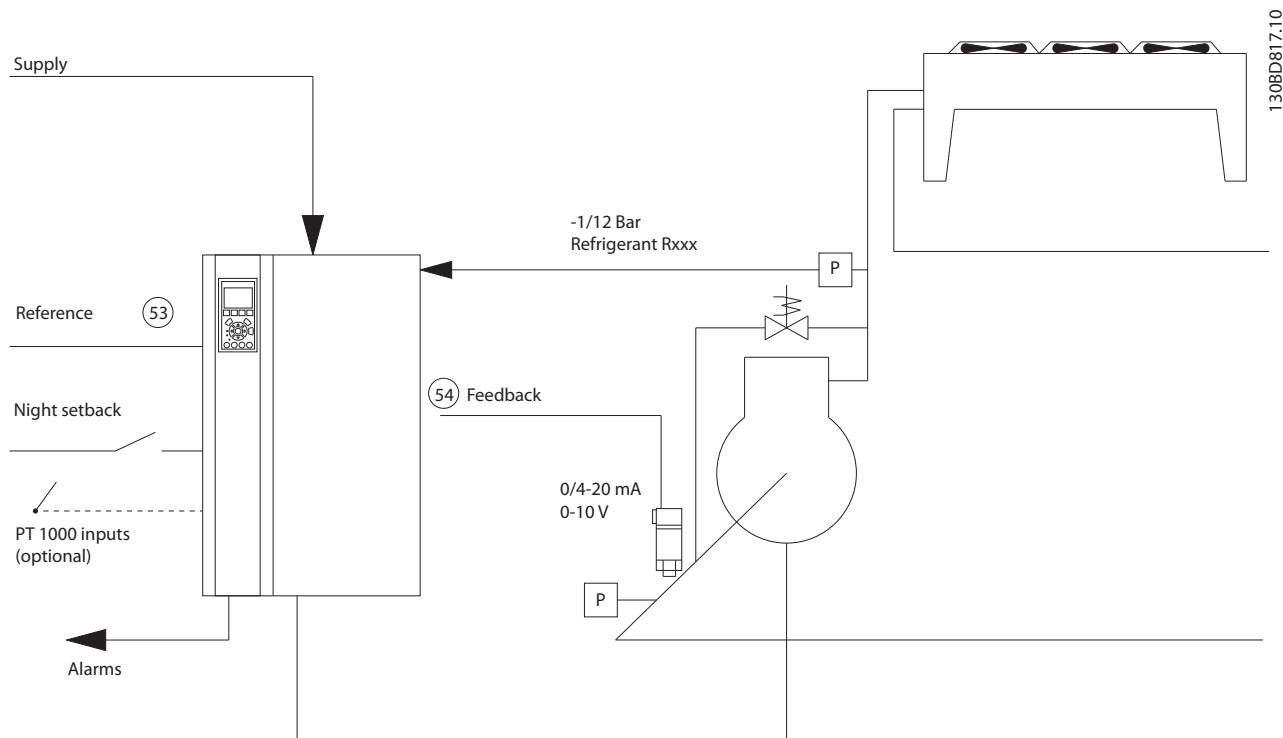


Figure 6.1 Standard Drawing of "Compressor with Internal Control"

SmartStart input:

- Bypass valve
- Recycling time (start to start)
- Min. Hz
- Max. Hz
- Setpoint
- Cut in/cut out
- 400/230 V AC
- Amps
- RPM

6.1.2 Single or Multiple Fans or Pumps

The SmartStart guides through the process of setting up of a refrigeration condenser fan or pump. Enter data about the condenser or pump and the refrigeration system on which the adjustable frequency drive will be running. All terminology and units used within the SmartStart are common refrigeration type and set-up is thus completed in 10-15 easy steps using two keys on the LCP.

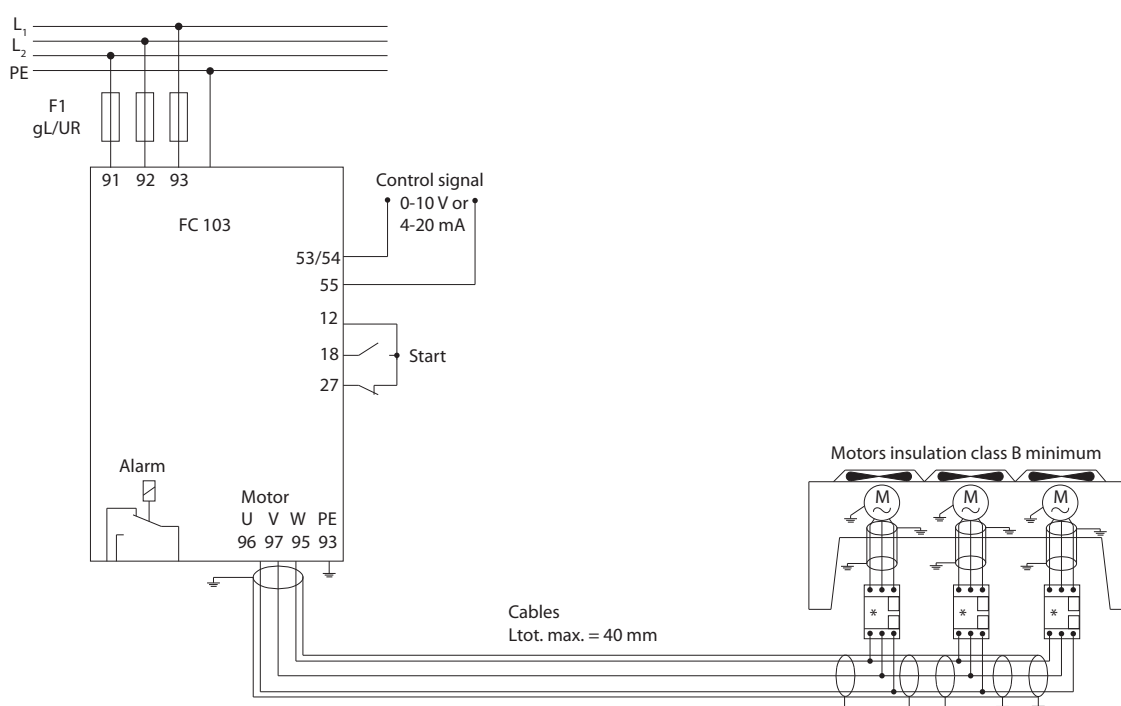


Figure 6.2 Speed Control Using Analog Reference (Open-loop) – Single Fan or Pump/Multiple Fans or Pumps in Parallel

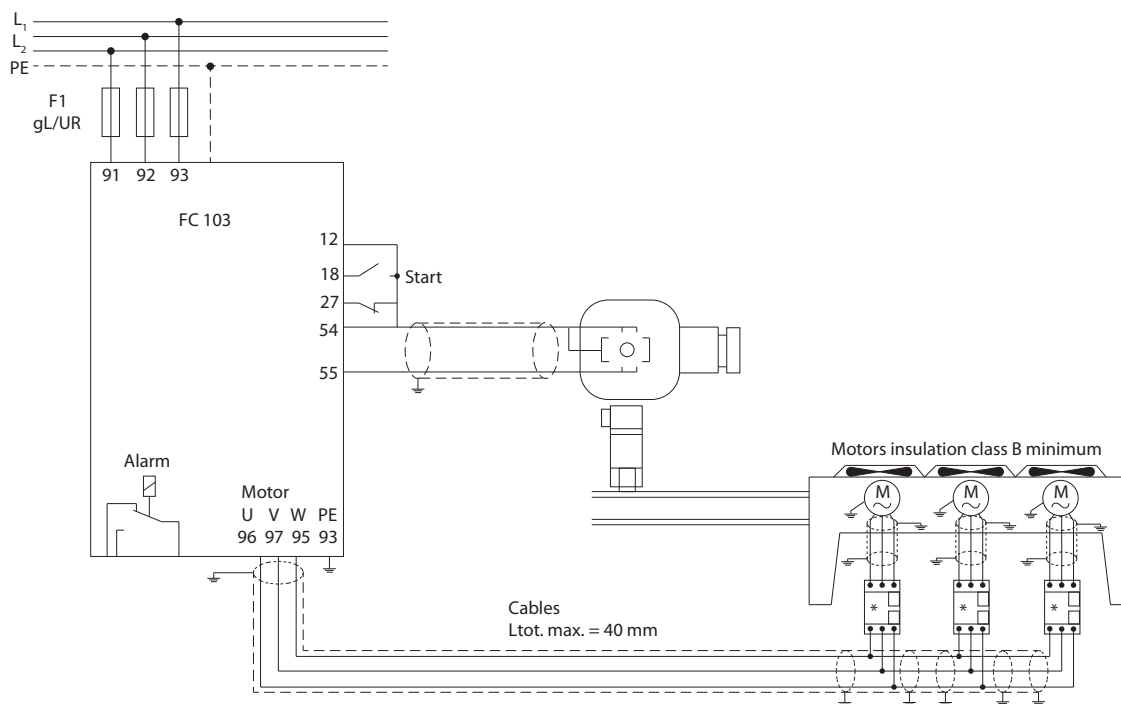


Figure 6.3 Pressure Control in Closed-loop – Stand Alone System – Single Fan or Pump/Multiple Fans or Pumps in Parallel

Recommended motor cable types are:

- LIYCY
- Lapp Oelflex 100CY 450/750 V
- Lapp Oelflex 110CY 600/1000 V
- Lapp Oelflex SERVO 2YSLCY-J9
- Lapp Oelflex SERVO 2YSLCYK-J9
- HELU TOPFLEX-EWV-2YSLCY-J
- HELU TOPFLEX-EWV-UV 2YSLCYK-J
- HELU TOPFLEX-EWV-3PLUS 2YSLCY-J
- HELU TOPFLEX-EWV-UV-3PLUS 2YSLCYK-J
- Faber Kabel EWV-Motorleitung 2YSL(St)Cyy
- nexans MOTIONLINE RHEXFLEX-EWV 2XSLSTCY-J

6.1.3 Compressor Pack

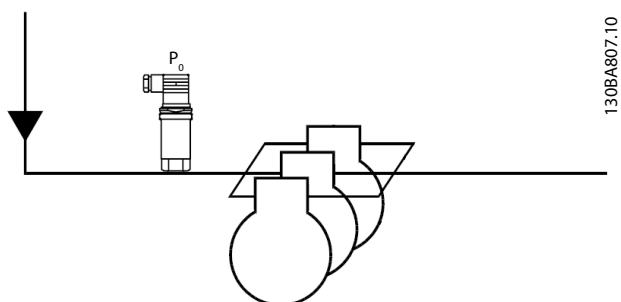


Figure 6.4 P₀ Pressure Transmitter

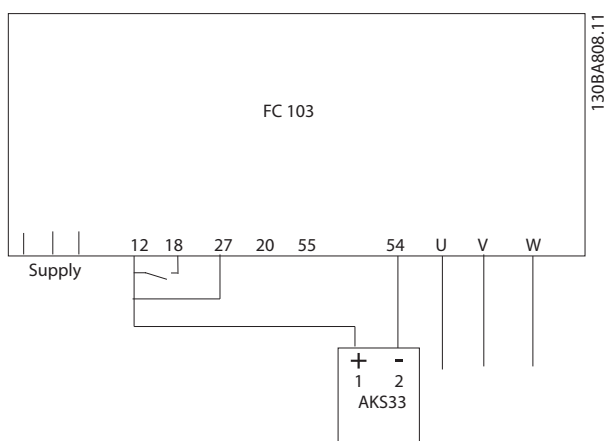


Figure 6.5 How to Connect the FC 103 and AKS33 for Closed-loop Applications

NOTICE!

To find out which parameters are relevant, run the SmartStart.

7 Maintenance, Diagnostics and Troubleshooting

This chapter includes maintenance and service guidelines, status messages, warnings and alarms and basic troubleshooting.

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the adjustable frequency drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the adjustable frequency drive at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, refer to www.danfoss.com/contact/sales_and_services/.

⚠ WARNING

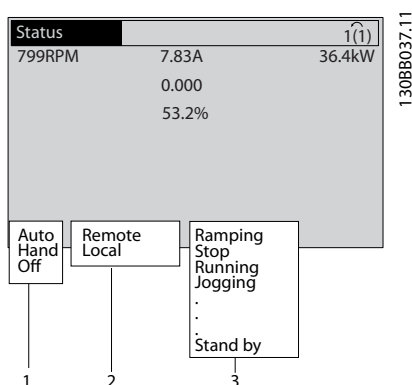
HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- Installation, start-up, and maintenance must be performed by qualified personnel only.

7.2 Status Messages

When the adjustable frequency drive is in status mode, status messages are generated automatically and appear in the bottom line of the display (see *Figure 7.1*).



| | |
|---|--|
| 1 | Operation mode (see <i>Table 7.1</i>) |
| 2 | Reference site (see <i>Table 7.2</i>) |
| 3 | Operation status (see <i>Table 7.3</i>) |

Figure 7.1 Status Display

Table 7.1 to *Table 7.3* describe the displayed status messages.

| | |
|---------|---|
| Off | The adjustable frequency drive does not react to any control signal until [Auto On] or [Hand On] is pressed. |
| Auto On | The adjustable frequency drive is controlled from the control terminals and/or the serial communication. |
| | The adjustable frequency drive is controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control. |

Table 7.1 Operation Mode

| | |
|--------|--|
| Remote | The speed reference is given from external signals, serial communication, or internal preset references. |
| Local | The adjustable frequency drive uses [Hand On] control or reference values from the LCP. |

Table 7.2 Reference Site

| | |
|-----------------|---|
| AC Brake | AC Brake was selected in <i>2-10 Brake Function</i> . The AC brake overmagnetizes the motor to achieve a controlled slow-down. |
| AMA finish OK | Automatic motor adaptation (AMA) was carried out successfully. |
| AMA ready | AMA is ready to start. Press [Hand On] to start. |
| AMA running | AMA process is in progress. |
| Coast | <ul style="list-style-type: none"> • Coast inverse was selected as a function for a digital input (parameter group <i>5-1* Digital Inputs</i>). The corresponding terminal is not connected. • Coast activated by serial communication |
| Ctrl. Ramp-down | Control Ramp-down was selected in <i>14-10 Mains Failure</i> . <ul style="list-style-type: none"> • The AC line voltage is below the value set in <i>14-11 Mains Voltage at Mains Fault</i> at line power fault • The adjustable frequency drive ramps down the motor using a controlled ramp-down. |
| Current High | The adjustable frequency drive output current is above the limit set in <i>4-51 Warning Current High</i> . |

| | |
|-----------------------|--|
| Current Low | The adjustable frequency drive output current is below the limit set in <i>4-52 Warning Speed Low</i> . |
| DC Hold | DC Hold is selected in <i>1-80 Function at Stop</i> and a stop command is active. The motor is held by a DC current set in <i>2-00 DC Hold/ Preheat Current</i> . |
| DC Stop | The motor is held with a DC current (<i>2-01 DC Brake Current</i>) for a specified time (<i>2-02 DC Braking Time</i>). <ul style="list-style-type: none"> DC Brake is activated in <i>2-03 DC Brake Cut-in Speed [RPM]</i> and a stop command is active. DC Brake (inverse) is selected as a function for a digital input (parameter group <i>5-1* Digital Inputs</i>). The corresponding terminal is not active. The DC Brake is activated via serial communication. |
| Feedback high | The sum of all active feedbacks is above the feedback limit set in <i>4-57 Warning Feedback High</i> . |
| Feedback low | The sum of all active feedbacks is below the feedback limit set in <i>4-56 Warning Feedback Low</i> . |
| Freeze output | The remote reference is active, which holds the present speed. <ul style="list-style-type: none"> Freeze output was selected as a function for a digital input (parameter group <i>5-1* Digital Inputs</i>). The corresponding terminal is active. Speed control is only possible via the terminal functions Speed Up and Slow. Hold ramp is activated via serial communication. |
| Freeze output request | A freeze output command was given but the motor remains stopped until a run permissive signal is received. |
| Freeze ref. | <i>Freeze Reference</i> was selected as a function for a digital input (parameter group <i>5-1* Digital Inputs</i>). The corresponding terminal is active. The adjustable frequency drive saves the actual reference. Changing the reference is now only possible via terminal functions Speed Up and Slow. |
| Jog request | A jog command was given but the motor remains stopped until a run permissive signal is received via a digital input. |

| | |
|---------------|---|
| Jogging | The motor is running as programmed in <i>3-19 Jog Speed [RPM]</i> . <ul style="list-style-type: none"> <i>Jog</i> was selected as function for a digital input (parameter group <i>5-1* Digital Inputs</i>). The corresponding terminal (e.g., Terminal 29) is active. The Jog function is activated via the serial communication. The Jog function was selected as a reaction for a monitoring function (e.g., No signal). The monitoring function is active. |
| Motor check | In <i>1-80 Function at Stop, Motor Check</i> was selected. A stop command is active. To ensure that a motor is connected to the adjustable frequency drive, a permanent test current is applied to the motor. |
| Over Voltage | <i>Overvoltage control</i> was activated in <i>2-17 Overvoltage Control, [2] Enabled</i> . The connected motor supplies the adjustable frequency drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the adjustable frequency drive from tripping. |
| PowerUnit Off | (Only adjustable frequency drives with an external 24 V power supply installed). Line power supply to the adjustable frequency drive was removed, and the control card is supplied by the external 24 V. |
| Protection md | Protection mode is active. The unit has detected a critical status (overcurrent or overvoltage). <ul style="list-style-type: none"> To avoid tripping, switching frequency is reduced to 4 kHz. If possible, protection mode ends after approximately 10 s. Protection mode can be restricted in <i>14-26 Trip Delay at Inverter Fault</i>. |
| Ramping | The motor is accelerating/decelerating using the active Ramp-Up/Down. The reference, a limit value, or a standstill is not yet reached. |
| Ref. high | The sum of all active references is above the reference limit set in <i>4-55 Warning Reference High</i> . |
| Ref. low | The sum of all active references is below the reference limit set in <i>4-54 Warning Reference Low</i> . |
| Run on ref. | The adjustable frequency drive is running in the reference range. The feedback value matches the setpoint value. |
| Run request | A start command was given but the motor remains stopped until a run permissive signal is received via digital input. |

| | |
|---------------|---|
| Running | The motor is driven by the adjustable frequency drive. |
| Sleep Mode | The energy-saving function is enabled. The motor has stopped but restarts automatically when required. |
| Speed high | Motor speed is above the value set in 4-53 <i>Warning Speed High</i> . |
| Speed low | Motor speed is below the value set in 4-52 <i>Warning Speed Low</i> . |
| Standby | In Auto On mode, the adjustable frequency drive starts the motor with a start signal from a digital input or serial communication. |
| Start delay | In 1-71 <i>Start Delay</i> , a delay starting time was set. A start command is activated and the motor starts after the start delay time expires. |
| Start fwd/rev | Start forward and start reverse were selected as functions for two different digital inputs (parameter group 5-1* <i>Digital Inputs</i>). The motor starts in forward or reverse depending on which corresponding terminal is activated. |
| Stop | The adjustable frequency drive has received a stop command from the LCP, digital input or serial communication. |
| Trip | An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the adjustable frequency drive can be reset manually by pressing [Reset] or remotely by control terminals or serial communication. |
| Trip lock | An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the adjustable frequency drive. The adjustable frequency drive can then be reset manually by pressing [Reset] or remotely by control terminals or serial communication. |

Table 7.3 Operation Status

NOTICE!

In auto/remote mode, the adjustable frequency drive requires external commands to execute functions.

7.3 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the adjustable frequency drive issuing an alarm. A warning clears by itself when the abnormal condition is removed.

Alarms

Trip

An alarm is issued when the adjustable frequency drive is tripped, which means that the adjustable frequency drive suspends operation to prevent adjustable frequency drive or system damage. The motor coasts to a stop. The adjustable frequency drive logic continues to operate and monitor the adjustable frequency drive status. After the fault condition is remedied, the adjustable frequency drive can be reset. It is then ready to start operation again.

Resetting the adjustable frequency drive after trip/trip lock

A trip can be reset in any of four ways:

- Press [Reset] on the LCP
- Digital reset input command
- Serial communication reset input command
- Auto reset

Trip lock

Input power is cycled. The motor coasts to a stop. The adjustable frequency drive continues to monitor the adjustable frequency drive status. Remove input power to the adjustable frequency drive, correct the cause of the fault, and reset the adjustable frequency drive.

Warning and Alarm Displays

- A warning is displayed in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

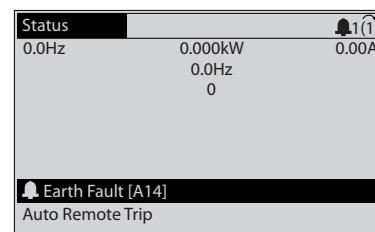
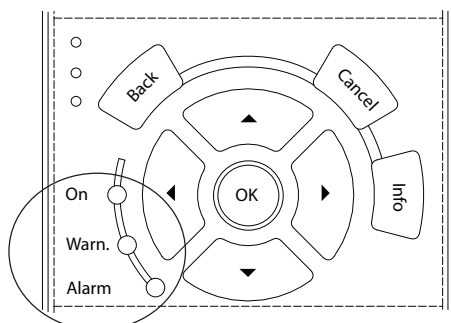


Figure 7.2 Alarm Display Example

In addition to the text and alarm code in the LCP, there are three status indicator lights.



130BB467.11

| | Warning LED | Alarm LED |
|-----------|-------------|---------------|
| Warning | On | Off |
| Alarm | Off | On (Flashing) |
| Trip Lock | On | On (Flashing) |

Figure 7.3 Status Indicator Lights

7.4 List of Warnings and Alarms

The warning/alarm information below defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

WARNING 1, 10 Volts low

The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω .

A short circuit in a connected potentiometer or improper wiring of the potentiometer can cause this condition.

Troubleshooting

- Remove the wiring from terminal 50. If the warning clears, the problem is with the wiring. If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error

This warning or alarm only appears if programmed in 6-01 Live Zero Timeout Function. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. MCB 101 terminals 11 and 12 for signals, terminal 10 common. MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common.
- Check that the adjustable frequency drive programming and switch settings match the analog signal type.
- Perform input terminal signal test.

WARNING/ALARM 4, Mains phase loss

A phase is missing on the supply side, or the line voltage imbalance is too high. This message also appears for a fault in the input rectifier on the adjustable frequency drive. Options are programmed at 14-12 Function at Mains Imbalance.

Troubleshooting

- Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5, DC link voltage high

The intermediate circuit voltage (DC) is higher than the high-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low

The intermediate circuit voltage (DC) is lower than the low-voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage

If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.

Troubleshooting

- Connect a brake resistor
- Extend the ramp time
- Change the ramp type
- Activate the functions in 2-10 Brake Function
- Increase 14-26 Trip Delay at Inverter Fault
- If the alarm/warning occurs during a power sag, use kinetic backup (14-10 Line Failure)

WARNING/ALARM 8, DC undervoltage

If the DC link voltage drops below the undervoltage limit, the adjustable frequency drive checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the adjustable frequency drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Make sure that the supply voltage matches the adjustable frequency drive voltage.
- Perform input voltage test.
- Perform soft charge circuit test.

WARNING/ALARM 9, Inverter overload

The adjustable frequency drive is about to cut out because of an overload (current too high for too long). The counter for electronic, thermal inverter protection issues a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive cannot be reset until the counter is below 90%.

The fault is that the adjustable frequency drive has run with more than 100% overload for too long.

Troubleshooting

- Compare the output current shown on the LCP with the adjustable frequency drive rated current.
- Compare the output current shown on the LCP with measured motor current.
- Display the thermal drive load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter increases. When running below the adjustable frequency drive continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the adjustable frequency drive issues a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded
- Check that the motor current set in 1-24 Motor Current is correct.
- Ensure that Motor data in parameters 1-20 to 1-25 are set correctly.
- If an external fan is in use, check in *1-91 Motor External Fan* that it is selected.
- Running AMA in *1-29 Automatic Motor Adaptation (AMA)* tunes the adjustable frequency drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over-temp

Check whether the thermistor is disconnected. Select whether the adjustable frequency drive issues a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check *1-93 Thermistor Source* selects terminal 53 or 54.
- When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50. Check *1-93 Thermistor Source* selects terminal 12 to 18, 19, 32 or 33.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.
- If torque limit occurs while running, possibly increase the torque limit. Make sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Overcurrent

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the adjustable frequency drive trips and issues an alarm. Shock loading or quick acceleration with high inertia loads can cause this fault. If the acceleration during ramp up is quick, the fault can also appear after kinetic backup. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Make sure that the motor size matches the adjustable frequency drive.
- Check parameters 1-20 to 1-25 for correct motor data.

ALARM 14, Ground fault

There is current from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself.

Troubleshooting

- Remove power to the adjustable frequency drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor leads and the motor with a megohmmeter.

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact Danfoss:

- 15-40 FC Type
- 15-41 Power Section
- 15-42 Voltage
- 15-43 Software Version
- 15-45 Actual Typecode String
- 15-49 SW ID Control Card
- 15-50 SW ID Power Card
- 15-60 Option Mounted
- 15-61 Option SW Version (for each option slot)

ALARM 16, Short-circuit

There is short-circuiting in the motor or motor wiring.

Remove power to the adjustable frequency drive and repair the short circuit.

WARNING/ALARM 17, Control word timeout

There is no communication to the adjustable frequency drive.

The warning is only active when *8-04 Control Word Timeout Function* is NOT set to [0] Off.

If *8-04 Control Word Timeout Function* is set to [5] Stop and Trip, a warning appears and the adjustable frequency drive ramps down until it stops then displays an alarm.

Troubleshooting

- Check connections on the serial communication cable.
- Increase *8-03 Control Word Timeout Time*
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

ALARM 18, Start failed

The speed has not been able to exceed *1-77 Compressor Start Max Speed [RPM]* during start within the allowed time. (set in *1-79 Compressor Start Max Time to Trip*). This may be caused by a blocked motor.

WARNING 23, Internal fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor ([0] Disabled)*.

For the D, E, and F-frame filters, the regulated voltage to the fans is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the adjustable frequency drive and check that the fan operates briefly at start-up.
- Check the sensors on the heatsink and control card.

WARNING 24, External fan fault

The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor ([0] Disabled)*.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the adjustable frequency drive and check that the fan operates briefly at start-up.
- Check the sensors on the heatsink and control card.

ALARM 29, Heatsink temp

The maximum temperature of the heatsink has been exceeded. The temperature fault does not reset until the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the adjustable frequency drive power size.

Troubleshooting

Check for the following conditions.

- Ambient temperature too high.
- Motor cable too long.
- Incorrect airflow clearance above and below the adjustable frequency drive.
- Blocked airflow around the adjustable frequency drive.
- Damaged heatsink fan.
- Dirty heatsink.

ALARM 30, Motor phase U missing

Motor phase U between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase U.

ALARM 31, Motor phase V missing

Motor phase V between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase V.

ALARM 32, Motor phase W missing

Motor phase W between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase W.

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault

The serial communication bus on the communication option card is not working.

WARNING/ALARM 36, Mains failure

This warning/alarm is only active if the supply voltage to the adjustable frequency drive is lost and *14-10 Mains Failure* is not set to [0] *No Function*. Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 7.4* is displayed.

Troubleshooting

- Cycle power
- Check that the option is properly installed
- Check for loose or missing wiring

It may be necessary to contact your Danfoss supplier or service department. Note the code number for further troubleshooting directions.

| No. | Text |
|-----------|---|
| 0 | Serial port cannot be initialized. Contact your Danfoss supplier or Danfoss Service Department. |
| 256-258 | Power EEPROM data is defective or too old. Replace power card. |
| 512-519 | Internal fault. Contact your Danfoss supplier or Danfoss Service Department. |
| 783 | Parameter value outside of min/max limits |
| 1024-1284 | Internal fault. Contact your Danfoss supplier or the Danfoss Service Department. |
| 1299 | Option SW in slot A is too old. |
| 1300 | Option SW in slot B is too old. |
| 1315 | Option SW in slot A is not supported (not allowed). |
| 1316 | Option SW in slot B is not supported (not allowed). |
| 1379-2819 | Internal fault. Contact your Danfoss supplier or Danfoss Service Department. |
| 1792 | HW reset of DSP. |
| 1793 | Motor-derived parameters not transferred correctly to DSP. |
| 1794 | Power data not transferred correctly at power-up to DSP. |
| 1795 | The DSP has received too many unknown SPI messages. |
| 1796 | RAM copy error. |
| 2561 | Replace control card. |
| 2820 | LCP stack overflow. |
| 2821 | Serial port overflow. |
| 2822 | USB port overflow. |
| 3072-5122 | Parameter value is outside its limits. |
| 5123 | Option in slot A: Hardware incompatible with control board hardware. |
| 5124 | Option in slot B: Hardware incompatible with control board hardware. |
| 5376-6231 | Internal fault. Contact your Danfoss supplier or Danfoss Service Department. |

Table 7.4 Internal Fault Codes

ALARM 39, Heatsink sensor

No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of digital output terminal 27

Check the load connected to terminal 27 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29

Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7

For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 45, Ground fault 2

Ground fault.

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check motor cables for short-circuits or leakage currents.

ALARM 46, Power card supply

The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ± 18 V. When powered with 24 V DC with the MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with three-phase AC line voltage, all three supplies are monitored.

Troubleshooting

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24 V DC power supply is used, verify proper supply power.

WARNING 47, 24 V supply low

The 24 V DC is measured on the control card. This alarm arises when the detected voltage of terminal 12 is lower than 18 V.

Troubleshooting

- Check for a defective control card.

WARNING 48, 1.8 V supply low

The 1.8 V DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit

When the speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the adjustable frequency drive shows a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping), the adjustable frequency drive trips.

ALARM 50, AMA calibration failed

Contact Danfoss supplier or Danfoss service department.

ALARM 51, AMA check U_{nom} and I_{nom}

The settings for motor voltage, motor current and motor power are wrong. Check the settings in parameters 1-20 to 1-25.

ALARM 52, AMA low I_{nom}

The motor current is too low. Check the settings.

ALARM 53, AMA motor too big

The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small

The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range

The parameter values of the motor are outside of the acceptable range. AMA cannot run.

ALARM 56, AMA interrupted by user

The user has interrupted the AMA.

ALARM 57, AMA internal fault

Try to restart AMA again. Repeated restarts can overheat the motor.

ALARM 58, AMA Internal fault

Contact the Danfoss supplier.

WARNING 59, Current limit

The current is higher than the value in *4-18 Current Limit*. Ensure that motor data in parameters 1–20 to 1–25 are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock

A digital input signal is indicating a fault condition external to the adjustable frequency drive. An external interlock has commanded the adjustable frequency drive to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock. Reset the adjustable frequency drive.

WARNING 62, Output frequency at maximum limit

The output frequency has reached the value set in *4-19 Max Output Frequency*. Check the application to determine the cause. Possibly increase the output frequency limit. Be sure the system can operate safely at a higher output frequency. The warning clears when the output drops below the maximum limit.

WARNING/ALARM 65, Control card overtemperature

The cut-out temperature of the control card is 176 °F [80 °C].

Troubleshooting

- Check that the ambient operating temperature is within limits.
- Check for clogged filters.
- Check fan operation.
- Check the control card.

WARNING 66, Heatsink temperature low

The adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the adjustable frequency drive whenever the motor is stopped by setting *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*.

ALARM 67, Option module configuration has changed

One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated

Safe Torque Off has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature

The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

- Check that the ambient operating temperature is within limits.
- Check for clogged filters.
- Check fan operation.
- Check the power card.

ALARM 70, Illegal FC configuration

The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code of the unit from the nameplate and the part numbers of the cards.

ALARM 80, Drive initialized to default value

Parameter settings are initialized to default settings after a manual reset. To clear the alarm, reset the unit.

ALARM 92, No-Flow

A no-flow condition has been detected in the system. *22-23 No-Flow Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 93, Dry pump

A no-flow condition in the system with the adjustable frequency drive operating at high speed may indicate a dry pump. *22-26 Dry Pump Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 94, End of curve

Feedback is lower than the setpoint. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 95, Broken belt

Torque is below the torque level set for no load, indicating a broken belt. *22-60 Broken Belt Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 96, Start delayed

Motor start has been delayed due to short-cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

WARNING 97, Stop delayed

Stopping the motor has been delayed due to short cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

WARNING 98, Clock fault

Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 203, Missing motor

With an adjustable frequency drive operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor

With an adjustable frequency drive operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

WARNING 250, New spare part

A component in the adjustable frequency drive has been replaced. Reset the adjustable frequency drive for normal operation.

WARNING 251, New type code

The power card or other components have been replaced and the type code changed. Reset to remove the warning and resume normal operation.

7.5 Troubleshooting

| Symptom | Possible cause | Test | Solution |
|----------------------------------|--|---|--|
| Display dark/No function | Missing input power | See <i>Table 4.3</i> | Check the input power source. |
| | Missing or open fuses or circuit breaker tripped | See open fuses and tripped circuit breaker in this table for possible causes. | Follow the recommendations provided. |
| | No power to the LCP | Check the LCP cable for proper connection or damage. | Replace the faulty LCP or connection cable. |
| | Shortcut on control voltage (terminal 12 or 50) or at control terminals | Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55. | Wire the terminals properly. |
| | Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM) | | Use only LCP 102 (P/N 130B1107). |
| | Wrong contrast setting | | Press [Status] + [▲]/[▼] to adjust the contrast. |
| | Display (LCP) is defective | Test using a different LCP. | Replace the faulty LCP or connection cable. |
| | Internal voltage supply fault or SMPS is defective | | Contact supplier. |
| Intermittent display | Overloaded power supply (SMPS) due to improper control wiring or a fault within the adjustable frequency drive | To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks. | If the display stays lit, then the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark. |
| Motor not running | Service switch open or missing motor connection | Check if the motor is connected and the connection is not interrupted (by a service switch or other device). | Connect the motor and check the service switch. |
| | No line power with 24 V DC option card | If the display is functioning but no output, check that line power is applied to the adjustable frequency drive. | Apply line power to run the unit. |
| | LCP Stop | Check if [Off] has been pressed. | Press [Auto On] or [Hand On] (depending on operation mode) to run the motor. |
| | Missing start signal (Standby) | Check <i>5-10 Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting). | Apply a valid start signal to start the motor. |
| | Motor coast signal active (Coasting) | Check <i>5-12 Coast inv.</i> for correct setting for terminal 27 (use default setting). | Apply 24 V on terminal 27 or program this terminal to <i>No operation</i> . |
| | Wrong reference signal source | Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available? | Program correct settings. Check <i>3-13 Reference Site</i> . Set preset reference active in parameter group <i>3-1* References</i> . Check for correct wiring. Check scaling of terminals. Check reference signal. |
| Motor running in wrong direction | Motor rotation limit | Check that <i>4-10 Motor Speed Direction</i> is programmed correctly. | Program correct settings. |
| | Active reversing signal | Check if a reversing command is programmed for the terminal in parameter group <i>5-1* Digital inputs</i> . | Deactivate reversing signal. |
| | Wrong motor phase connection | | See <i>chapter 5.5 Checking Motor Rotation</i> . |

| Symptom | Possible cause | Test | Solution |
|--|---|---|---|
| Motor is not reaching maximum speed | Frequency limits set wrong | Check output limits in 4-13 <i>Motor Speed High Limit [RPM]</i> , 4-14 <i>Motor Speed High Limit [Hz]</i> and 4-19 <i>Max Output Frequency</i> . | Program correct limits. |
| | Reference input signal not scaled correctly | Check reference input signal scaling in 6-0* <i>Analog I/O Mode</i> and parameter group 3-1* <i>References</i> . Reference limits in parameter group 3-0* <i>Reference Limits</i> . | Program correct settings. |
| Motor speed unstable | Possible incorrect parameter settings | Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings. | Check settings in parameter group 1-6* <i>Load Depen.Setting</i> . For closed-loop operation, check settings in parameter group 20-0* <i>Feedback</i> . |
| Motor runs rough | Possible overmagnetization | Check for incorrect motor settings in all motor parameters. | Check motor settings in parameter groups 1-2* <i>Motor Data</i> , 1-3* <i>Addl. Motor Data</i> , and 1-5* <i>Load Indep. Setting</i> . |
| Motor will not brake | Possible incorrect settings in the brake parameters. Possible too short ramp-down times | Check brake parameters. Check ramp time settings. | Check parameter group 2-0* <i>DC Brake</i> and 3-0* <i>Reference Limits</i> . |
| Open power fuses or circuit breaker trip | Phase-to-phase short | Motor or panel has a short phase-to-phase. Check motor and panel phase for shorts. | Eliminate any short circuits detected. |
| | Motor overload | Motor is overloaded for the application. | Perform start-up test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application. |
| | Loose connections | Perform pre-start-up check for loose connections | Tighten loose connections. |
| Line power current imbalance greater than 3% | Problem with line power (See <i>Alarm 4 Mains phase loss</i> description) | Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A. | If imbalanced leg follows the wire, it is a power problem. Check line power supply. |
| | Problem with the adjustable frequency drive | Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A. | If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier. |
| Motor current imbalance greater than 3% | Problem with motor or motor wiring | Rotate output motor leads one position: U to V, V to W, W to U. | If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring. |
| | Problem with the adjustable frequency drives | Rotate output motor leads one position: U to V, V to W, W to U. | If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier. |
| Adjustable frequency drive acceleration problems | Motor data are entered incorrectly | If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data are entered correctly | Increase the ramp-up time in 3-41 <i>Ramp 1 Ramp-up Time</i> . Increase ramp 3-80 <i>Jog</i> and 3-82 <i>Starting ramp-up time</i> . Increase current limit in 4-18 <i>Current Limit</i> . Increase torque limit in 4-16 <i>Torque Limit Motor Mode</i> . |
| Adjustable frequency drive deceleration problems | Motor data are entered incorrectly | If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data are entered correctly | Increase the ramp-down time in 3-42 <i>Ramp 1 Ramp-down Time</i> . Enable overvoltage control in 2-17 <i>Over-voltage Control</i> . |

| Symptom | Possible cause | Test | Solution |
|--|---|---|---|
| Acoustic noise or vibration (e.g., a fan blade is making noise or vibrations at certain frequencies) | Resonances, e.g., in the motor/fan system | Bypass critical frequencies by using parameters in parameter group 4-6* <i>Speed Bypass</i> . | Check if noise and/or vibration have been reduced to an acceptable limit. |
| | | Turn off overmodulation in 14-03 <i>Overmodulation</i> . | |
| | | Change switching pattern and frequency in parameter group 14-0* <i>Inverter Switching</i> . | |
| | | Increase Resonance Dampening in 1-64 <i>Resonance Dampening</i> . | |

Table 7.5 Troubleshooting

8 Specifications

8.1 Electrical Data

8.1.1 Line Power Supply 3x200–240 V AC

| Type Designation | P1K1 | P1K5 | P2K2 | P3K0 | P3K7 |
|--|---|-------|-------|------|------|
| Typical Shaft Output [kW] | 1.1 | 1.5 | 2.2 | 3.0 | 3.7 |
| Typical Shaft Output [HP] at 208 V | 1.5 | 2.0 | 2.9 | 4.0 | 4.9 |
| IP20/Chassis ⁶⁾ | A2 | A2 | A2 | A3 | A3 |
| IP55/Type 12 | A4/A5 | A4/A5 | A4/A5 | A5 | A5 |
| IP66/NEMA 4X | A4/A5 | A4/A5 | A4/A5 | A5 | A5 |
| Output current | | | | | |
| Continuous (3x200–240 V) [A] | 6.6 | 7.5 | 10.6 | 12.5 | 16.7 |
| Intermittent (3x200–240 V) [A] | 7.3 | 8.3 | 11.7 | 13.8 | 18.4 |
| Continuous kVA (208 V AC) [kVA] | 2.38 | 2.70 | 3.82 | 4.50 | 6.00 |
| Max. input current | | | | | |
| Continuous (3x200–240 V) [A] | 5.9 | 6.8 | 9.5 | 11.3 | 15.0 |
| Intermittent (3x200–240 V) [A] | 6.5 | 7.5 | 10.5 | 12.4 | 16.5 |
| Additional specifications | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 63 | 82 | 116 | 155 | 185 |
| IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² /(AWG)] | 4, 4, 4 (12, 12, 12) (min. 0.2 (24)) | | | | |
| IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ² /(AWG)] | 4, 4, 4 (12, 12, 12) | | | | |
| Max. cable cross-section with disconnect | 6, 4, 4 (10, 12, 12) | | | | |
| Efficiency ³⁾ | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |

Table 8.1 Line Power Supply 3x200–240 V AC - Normal overload 110% for 1 minute, P1K1-P3K7

| Type Designation | P5K5 | P7K5 | P11K | P15K | P18K | P22K | P30K | P37K | P45K |
|--|----------------------|------|--|--------|--------|------|-------|---------------|-------|
| Typical Shaft Output [kW] | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 |
| Typical Shaft Output [HP] at 208 V | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 |
| IP20/Chassis ⁷⁾ | B3 | B3 | B3 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP55/Type 12 | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP66/NEMA 4X | B1 | B1 | B1 | B2 | C1 | C1 | C1 | C2 | C2 |
| Output current | | | | | | | | | |
| Continuous (3x200–240 V) [A] | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 115 | 143 | 170 |
| Intermittent (3x200–240 V) [A] | 26.6 | 33.9 | 50.8 | 65.3 | 82.3 | 96.8 | 127 | 157 | 187 |
| Continuous kVA (208 V AC) [kVA] | 8.7 | 11.1 | 16.6 | 21.4 | 26.9 | 31.7 | 41.4 | 51.5 | 61.2 |
| Max. input current | | | | | | | | | |
| Continuous (3x200–240 V) [A] | 22.0 | 28.0 | 42.0 | 54.0 | 68.0 | 80.0 | 104.0 | 130.0 | 154.0 |
| Intermittent (3x200–240 V) [A] | 24.2 | 30.8 | 46.2 | 59.4 | 74.8 | 88.0 | 114.0 | 143.0 | 169.0 |
| Additional Specifications | | | | | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 269 | 310 | 447 | 602 | 737 | 845 | 1140 | 1353 | 1636 |
| IP20 max. cable cross-section (line power, brake, motor and load sharing) [mm ² /(AWG)] | 10, 10 (8,8,-) | | 35 _{r,r} (2 _{r,r} -) | 35 (2) | 50 (1) | | | 150 (300 MCM) | |
| IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² /(AWG)] | 10, 10 (8,8,-) | | 35, 25, 25 (2, 4, 4) | | 50 (1) | | | 150 (300 MCM) | |
| IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² /(AWG)] | 16, 10, 16 (6, 8, 6) | | 35 _{r,r} (2 _{r,r} -) | | 50 (1) | | | 95 (3/0) | |
| Efficiency ³⁾ | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 |

Table 8.2 Line Power Supply 3x200–240 V AC - Normal overload 110% for 1 minute, P5K5-P45K

8.1.2 Line Power Supply 3x380–480 V AC

| Type Designation | P1K1 | P1K5 | P2K2 | P3K0 | P4K0 | P5K5 | P7K5 |
|--|---|-------|-------|-------|-------|------|------|
| Typical Shaft Output [kW] | 1.1 | 1.5 | 2.2 | 3.0 | 4.0 | 5.5 | 7.5 |
| Typical Shaft Output [HP] at 460 V | 1.5 | 2.0 | 2.9 | 4.0 | 5.0 | 7.5 | 10 |
| IP20/Chassis ⁶⁾ | A2 | A2 | A2 | A2 | A2 | A3 | A3 |
| IP55/Type 12 | A4/A5 | A4/A5 | A4/A5 | A4/A5 | A4/A5 | A5 | A5 |
| IP66/NEMA 4X | A4/A5 | A4/A5 | A4/A5 | A4/A5 | A4/A5 | A5 | A5 |
| Output current | | | | | | | |
| Continuous (3x380–440 V) [A] | 3 | 4.1 | 5.6 | 7.2 | 10 | 13 | 16 |
| Intermittent (3x380–440 V) [A] | 3.3 | 4.5 | 6.2 | 7.9 | 11 | 14.3 | 17.6 |
| Continuous (3x441–480 V) [A] | 2.7 | 3.4 | 4.8 | 6.3 | 8.2 | 11 | 14.5 |
| Intermittent (3x441–480 V) [A] | 3.0 | 3.7 | 5.3 | 6.9 | 9.0 | 12.1 | 15.4 |
| Continuous kVA (400 V AC) [kVA] | 2.1 | 2.8 | 3.9 | 5.0 | 6.9 | 9.0 | 11.0 |
| Continuous kVA (460 V AC) [kVA] | 2.4 | 2.7 | 3.8 | 5.0 | 6.5 | 8.8 | 11.6 |
| Max. input current | | | | | | | |
| Continuous (3x380–440 V) [A] | 2.7 | 3.7 | 5.0 | 6.5 | 9.0 | 11.7 | 14.4 |
| Intermittent (3x380–440 V) [A] | 3.0 | 4.1 | 5.5 | 7.2 | 9.9 | 12.9 | 15.8 |
| Continuous (3x441–480 V) [A] | 2.7 | 3.1 | 4.3 | 5.7 | 7.4 | 9.9 | 13.0 |
| Intermittent (3x441–480 V) [A] | 3.0 | 3.4 | 4.7 | 6.3 | 8.1 | 10.9 | 14.3 |
| Additional specifications | | | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 58 | 62 | 88 | 116 | 124 | 187 | 255 |
| IP20, IP21 max. cable cross-section (line power, motor, brake and load sharing) [mm ² /(AWG)] ²⁾ | 4, 4, 4 (12, 12, 12) (min. 0.2 (24)) | | | | | | |
| IP55, IP66 max. cable cross-section (line power, motor, brake and load sharing) [mm ² /(AWG)] ²⁾ | 4, 4, 4 (12, 12, 12) | | | | | | |
| Max. cable cross-section with disconnect | 6, 4, 4 (10, 12, 12) | | | | | | |
| Efficiency ³⁾ | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 |

Table 8.3 Line Power Supply 3x380–480 V AC - Normal overload 110% for 1 minute, P1K1-P7K5

| Type Designation | P11K | P15K | P18K | P22K | P30K | P37K | P45K | P55K | P75K | P90K |
|--|----------------------|------|----------------------|------|--------|--------|------|------|---------------|--------------|
| Typical Shaft Output [kW] | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| Typical Shaft Output [HP] at 460 V | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 75 | 100 | 125 |
| IP20/Chassis ⁷⁾ | B3 | B3 | B3 | B4 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP55/Type 12 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP66/NEMA 4X | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| Output current | | | | | | | | | | |
| Continuous (3x380-439 V) [A] | 24 | 32 | 37.5 | 44 | 61 | 73 | 90 | 106 | 147 | 177 |
| Intermittent (3x380-439 V) [A] | 26.4 | 35.2 | 41.3 | 48.4 | 67.1 | 80.3 | 99 | 117 | 162 | 195 |
| Continuous (3x440-480 V) [A] | 21 | 27 | 34 | 40 | 52 | 65 | 80 | 105 | 130 | 160 |
| Intermittent (3x440-480 V) [A] | 23.1 | 29.7 | 37.4 | 44 | 61.6 | 71.5 | 88 | 116 | 143 | 176 |
| Continuous kVA (400 V AC) [kVA] | 16.6 | 22.2 | 26 | 30.5 | 42.3 | 50.6 | 62.4 | 73.4 | 102 | 123 |
| Continuous kVA (460 V AC) [kVA] | 16.7 | 21.5 | 27.1 | 31.9 | 41.4 | 51.8 | 63.7 | 83.7 | 104 | 128 |
| Max. input current | | | | | | | | | | |
| Continuous (3x380-439 V) [A] | 22 | 29 | 34 | 40 | 55 | 66 | 82 | 96 | 133 | 161 |
| Intermittent (3x380-439 V) [A] | 24.2 | 31.9 | 37.4 | 44 | 60.5 | 72.6 | 90.2 | 106 | 146 | 177 |
| Continuous (3x440-480 V) [A] | 19 | 25 | 31 | 36 | 47 | 59 | 73 | 95 | 118 | 145 |
| Intermittent (3x440-480 V) [A] | 20.9 | 27.5 | 34.1 | 39.6 | 51.7 | 64.9 | 80.3 | 105 | 130 | 160 |
| Additional specifications | | | | | | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 278 | 392 | 465 | 525 | 698 | 739 | 843 | 1083 | 1384 | 1474 |
| IP20 max. cable cross-section (line power, brake, motor and load sharing) [mm ² /(AWG)] | 16, 10, - (8, 8, -) | | 35, -, - (2, -, -) | | 35 (2) | 50 (1) | | | 150 (300 MCM) | |
| IP21, IP55, IP66 max. cable cross-section (line power, motor) [mm ² /(AWG)] | 10, 10, 16 (6, 6, 6) | | 35, 25, 25 (2, 4, 4) | | 50 (1) | | | | 150 (300 MCM) | |
| IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm ² /(AWG)] | 10, 10, - (8, 8, -) | | 35, -, - (2, -, -) | | 50 (1) | | | | 95 (3/0) | |
| With line power disconnect switch included | | | 16/6 | | | 35/2 | 35/2 | | 70/3/0 | 185/kcmil350 |
| Efficiency ³⁾ | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 |

Table 8.4 Line Power Supply 3x380-480 V AC - Normal overload 110% for 1 minute, P11K-P90K

8.1.3 Line Power Supply 3x525–600 V AC

| Type Designation | P1K1 | P1K5 | P2K2 | P3K0 | P3K7 | P4K0 | P5K5 | P7K5 |
|---|---|------|------|------|------|------|------|------|
| Typical Shaft Output [kW] | 1.1 | 1.5 | 2.2 | 3.0 | 3.7 | 4.0 | 5.5 | 7.5 |
| IP20/Chassis | A3 | A3 | A3 | A3 | A2 | A3 | A3 | A3 |
| IP21/NEMA 1 | A3 | A3 | A3 | A3 | A2 | A3 | A3 | A3 |
| IP55/Type 12 | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 |
| IP66/NEMA 4X | A5 | A5 | A5 | A5 | A5 | A5 | A5 | A5 |
| Output current | | | | | | | | |
| Continuous (3 x 525–550 V) [A] | 2.6 | 2.9 | 4.1 | 5.2 | - | 6.4 | 9.5 | 11.5 |
| Intermittent (3 x 525–550 V) [A] | 2.9 | 3.2 | 4.5 | 5.7 | - | 7.0 | 10.5 | 12.7 |
| Continuous (3x525–600 V) [A] | 2.4 | 2.7 | 3.9 | 4.9 | - | 6.1 | 9.0 | 11.0 |
| Intermittent (3x525–600 V) [A] | 2.6 | 3.0 | 4.3 | 5.4 | - | 6.7 | 9.9 | 12.1 |
| Continuous kVA (525 V AC) [kVA] | 2.5 | 2.8 | 3.9 | 5.0 | - | 6.1 | 9.0 | 11.0 |
| Continuous kVA (575 V AC) [kVA] | 2.4 | 2.7 | 3.9 | 4.9 | - | 6.1 | 9.0 | 11.0 |
| Max. input current | | | | | | | | |
| Continuous (3x525–600 V) [A] | 2.4 | 2.7 | 4.1 | 5.2 | - | 5.8 | 8.6 | 10.4 |
| Intermittent (3x525–600 V) [A] | 2.7 | 3.0 | 4.5 | 5.7 | - | 6.4 | 9.5 | 11.5 |
| Additional specifications | | | | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 50 | 65 | 92 | 122 | - | 145 | 195 | 261 |
| IP20 max. cable cross-section ⁵⁾ (line power, motor, brake and load sharing) [mm ² /(AWG)] | 4, 4, 4 (12, 12, 12) (min. 0.2 (24)) | | | | | | | |
| IP55, IP 66 max. cable cross-section ⁵⁾ (line power, motor, brake and load sharing) [mm ² /(AWG)] | 4, 4, 4 (12, 12, 12) (min. 0.2 (24)) | | | | | | | |
| Max. cable cross-section with disconnect | 6, 4, 4 (12, 12, 12) | | | | | | | |
| Line power disconnect switch included | 4/12 | | | | | | | |
| Efficiency ³⁾ | 0.97 | 0.97 | 0.97 | 0.97 | - | 0.97 | 0.97 | 0.97 |

Table 8.5 Line Power Supply 3x525–600 V AC - Normal overload 110% for 1 minute, P1K1-P7K5

| Type Designation | P11K | P15K | P18K | P22K | P30K | P37K | P45K | P55K | P75K | P90K |
|---|----------------------|------|----------------------|------|----------------------|--------------------|------|----------------------------|---------------------------------------|--------------|
| Typical Shaft Output [kW] | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| IP20/Chassis | B3 | B3 | B3 | B4 | B4 | B4 | C3 | C3 | C4 | C4 |
| IP21/NEMA 1 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP55/Type 12 | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| IP66/NEMA 4X | B1 | B1 | B1 | B2 | B2 | C1 | C1 | C1 | C2 | C2 |
| Output current | | | | | | | | | | |
| Continuous (3 x 525-550 V) [A] | 19 | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 | 137 |
| Intermittent (3 x 525-550 V) [A] | 21 | 25 | 31 | 40 | 47 | 59 | 72 | 96 | 116 | 151 |
| Continuous (3x525-600 V) [A] | 18 | 22 | 27 | 34 | 41 | 52 | 62 | 83 | 100 | 131 |
| Intermittent (3x525-600 V) [A] | 20 | 24 | 30 | 37 | 45 | 57 | 68 | 91 | 110 | 144 |
| Continuous kVA (525 V AC) [kVA] | 18.1 | 21.9 | 26.7 | 34.3 | 41 | 51.4 | 61.9 | 82.9 | 3.94 [100] | 130.5 |
| Continuous kVA (575 V AC) [kVA] | 17.9 | 21.9 | 26.9 | 33.9 | 40.8 | 51.8 | 61.7 | 82.7 | 99.6 | 130.5 |
| Max. input current | | | | | | | | | | |
| Continuous (3x525-600 V) [A] | 17.2 | 20.9 | 25.4 | 32.7 | 39 | 49 | 59 | 78.9 | 95.3 | 124.3 |
| Intermittent (3x525-600 V) [A] | 19 | 23 | 28 | 36 | 43 | 54 | 65 | 87 | 105 | 137 |
| Additional specifications | | | | | | | | | | |
| Estimated power loss at rated max. load [W] ⁴⁾ | 300 | 400 | 475 | 525 | 700 | 750 | 850 | 1100 | 1400 | 1500 |
| IP21, IP55, IP66 max. cable cross-section (line power, brake and load sharing) [mm ² /(AWG)] | 16, 10, 10 (6, 8, 8) | | 35, -, - (2, -, -) | | | 50, -, - (1, -, -) | | | 95 (4/0) | |
| IP21, IP55, IP66 max. cable cross-section (motor) [mm ² /(AWG)] | 10, 10, - (8, 8, -) | | 35, 25, 25 (2, 4, 4) | | | 50, -, - (1, -, -) | | | 150 (300 MCM) | |
| IP20 max. cable cross-section (line power, brake and load sharing) [mm ² /(AWG)] | 10, 10, - (8, 8, -) | | 35, -, - (2, -, -) | | | 50, -, - (1, -, -) | | | 150 (300 MCM) | |
| Max. cable cross-section with disconnect | 16, 10, 10 (6, 8, 8) | | | | 50, 35, 35 (1, 2, 2) | | | 95, 70, 70 (3/0, 2/0, 2/0) | 185, 150, 120 (350 MCM, 300 MCM, 4/0) | |
| Line power disconnect switch included | | | 16/6 | | | | 35/2 | | 70/3/0 | 185/kcmil350 |
| Efficiency ³⁾ | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

Table 8.6 Line Power Supply 3x525-600 V AC - Normal overload 110% for 1 minute, P11K-P90K

¹⁾ For type of fuse, see chapter 8.8 Fuses and Circuit Breakers.

²⁾ American Wire Gauge.

³⁾ Measured using 16 ft [5 m] shielded motor cables at rated load and rated frequency.

⁴⁾ The typical power loss is at normal load conditions and expected to be within $\pm 15\%$ (tolerance relates to variety in voltage and cable conditions).

Values are based on a typical motor efficiency. Lower efficiency motors will also add to the power loss in the adjustable frequency drive and vice versa.

If the switching frequency is raised from nominal, the power losses may rise significantly.

LCP and typical control card power consumption values are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each).

Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for ($\pm 5\%$).

⁵⁾ The three values for the max. cable cross-section are for single core, flexible wire and flexible wire with sleeve, respectively. Motor and line cable: 300 MCM/150 mm².

⁶⁾ A2+A3 may be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

⁷⁾ B3+4 and C3+4 may be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

8.2 Line Power Supply

Line power supply

| | |
|------------------|----------------------|
| Supply Terminals | L1, L2, L3 |
| Supply voltage | 200–240 V $\pm 10\%$ |
| Supply voltage | 380–480 V $\pm 10\%$ |
| Supply voltage | 525–600 V $\pm 10\%$ |

AC line voltage low/line drop-out:

During low AC line voltage or a line drop-out, the adjustable frequency drive continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the adjustable frequency drive's lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the adjustable frequency drive's lowest rated supply voltage.

| | |
|--|---|
| Supply frequency | 50/60 Hz $\pm 5\%$ |
| Max. temporary imbalance between line phases | 3.0% of rated supply voltage |
| True Power Factor (λ) | ≥ 0.9 nominal at rated load |
| Displacement Power Factor ($\cos \phi$) | Near unity (> 0.98) |
| Switching on input supply L1, L2, L3 (power-ups) ≤ 7.5 kW | Maximum 2 times/min. |
| Switching on input supply L1, L2, L3 (power-ups) 11–75 kW | Maximum 1 time/min. |
| Switching on input supply L1, L2, L3 (power-ups) ≥ 90 kW | Maximum 1 time/2 min. |
| Environment according to EN60664-1 | Overvoltage category III/pollution degree 2 |

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240/500/600/690 V maximum.

8.3 Motor Output and Motor Data

Motor output (U, V, W)

| | |
|------------------------------|--------------------------|
| Output voltage | 0–100% of supply voltage |
| Output frequency (1.1–90 kW) | 0–590 ¹⁾ Hz |
| Switching on output | Unlimited |
| Ramp times | 1–3600 s |

¹⁾ As of software version 1.10, the output frequency of the adjustable frequency drive is limited to 590 Hz. Contact local Danfoss partner for further information.

Torque characteristics

| | |
|-----------------------------------|--|
| Starting torque (Constant torque) | maximum 110% for 1 min. ¹⁾ |
| Starting torque | maximum 135% up to 0.5 s ¹⁾ |
| Overload torque (Constant torque) | maximum 110% for 1 min. ¹⁾ |

¹⁾ Percentage relates to the nominal torque.

8.4 Ambient Conditions

Environment

| | |
|---|---|
| IP rating | IP20 ¹⁾ /Chassis, IP21 ²⁾ /Type 1, IP55/Type 12, IP66/Type 4X |
| Vibration test | 1.0 g |
| Max. relative humidity | 5%–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation |
| Aggressive environment (IEC 60068-2-43) H ₂ S test | class Kd |
| Ambient temperature ³⁾ | Max. 122°F [50°C] (24-hour average maximum 113°F [45°C]) |
| Minimum ambient temperature during full-scale operation | 32°F [0°C] |
| Minimum ambient temperature at reduced performance | 14°F [-10°C] |
| Temperature during storage/transport | -13°–+149°/158°F [-25°–+65°/70°C] |
| Maximum altitude above sea level without derating | 3300 ft [1000 m] |

Derating for high altitude, see special conditions in the Design Guide.

| | |
|-------------------------|------------|
| EMC standards, Emission | EN 61800-3 |
| EMC standards, Immunity | EN 61800-3 |

See section on special conditions in the Design Guide.

¹⁾ Only for ≤ 3.7 kW (200–240 V), ≤ 7.5 kW (380–480 V)

²⁾ As enclosure kit for ≤ 3.7 kW (200–240 V), ≤ 7.5 kW (380–480 V)

³⁾ Derating for high ambient temperature, see special conditions in the Design Guide

8.5 Cable Specifications

Cable lengths and cross-sections for control cables¹⁾

| | |
|--|------------------------------|
| Max. motor cable length, shielded | 500 ft [150 m] |
| Max. motor cable length, non-shielded | 1000 ft [300 m] |
| Maximum cross-section to control terminals, flexible/ rigid wire without cable end sleeves | 1.5 mm ² /16 AWG |
| Maximum cross-section to control terminals, flexible wire with cable end sleeves | 1 mm ² /18 AWG |
| Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar | 0.5 mm ² /20 AWG |
| Minimum cross-section to control terminals | 0.25 mm ² /24 AWG |

¹⁾ For power cables, see electrical data tables in chapter 8.1 Electrical Data.

8.6 Control Input/Output and Control Data

Digital inputs

| | |
|---|---|
| Programmable digital inputs | 4 (6) ¹⁾ |
| Terminal number | 18, 19, 27 ¹⁾ , 29 ¹⁾ , 32, 33, |
| Logic | PNP or NPN |
| Voltage level | 0–24 V DC |
| Voltage level, logic '0' PNP | <5 V DC |
| Voltage level, logic '1' PNP | >10 V DC |
| Voltage level, logic '0' NPN ²⁾ | >19 V DC |
| Voltage level, logic '1' NPN ²⁾ | <14 V DC |
| Maximum voltage on input | 28 V DC |
| Pulse frequency ranges (Duty cycle) Min. pulse width | 0–110 kHz 4.5 ms |
| Input resistance, R_i | Approx. 4 k Ω |

Safe Torque Off Terminal 37³⁾, ⁴⁾ (Terminal 37 is fixed PNP logic)

| | |
|-------------------------------|-----------|
| Voltage level | 0–24 V DC |
| Voltage level, logic '0' PNP | <4 V DC |
| Voltage level, logic '1' PNP | >20 V DC |
| Maximum voltage on input | 28 V DC |
| Typical input current at 24 V | 50 mA rms |
| Typical input current at 20 V | 60 mA rms |
| Input capacitance | 400 nF |

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

¹⁾ Terminals 27 and 29 can also be programmed as output.

²⁾ Except Safe Torque Off input Terminal 37.

³⁾ See chapter 4.8 Control Wiring for further information about terminal 37 and Safe Torque Off.

⁴⁾ When using a contactor with a DC coil inside in combination with Safe Torque Off, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

Analog inputs

| | |
|------------------------------|-----------------------------------|
| Number of analog inputs | 2 |
| Terminal number | 53, 54 |
| Modes | Voltage or current |
| Mode select | Switch S201 and switch S202 |
| Voltage mode | Switch S201/switch S202 = OFF (U) |
| Voltage level | -10 to +10 V (scaleable) |
| Input resistance, R_i | Approx. 10 k Ω |
| Max. voltage | \pm 20 V |
| Current mode | Switch S201/switch S202 = ON (I) |
| Current level | 0/4 to 20 mA (scaleable) |
| Input resistance, R_i | Approx. 200 Ω |
| Max. current | 30 mA |
| Resolution for analog inputs | 10 bit (+ sign) |
| Accuracy of analog inputs | Max. error 0.5% of full scale |
| Bandwidth | 100 Hz |

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

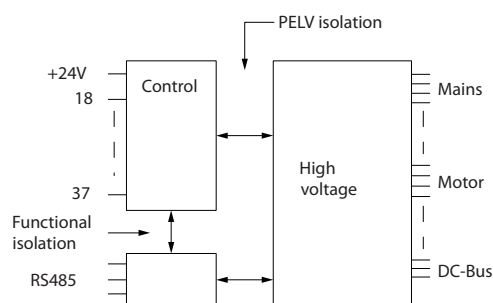


Figure 8.1 PELV Isolation of Analog Inputs

Pulse inputs

| | |
|---------------------------------------|---|
| Programmable pulse | 2/1 |
| Terminal number pulse | 29, 33 ¹⁾ /32 ²⁾ , 33 ²⁾ |
| Max. frequency at terminal 29, 32, 33 | 110 kHz (push-pull driven) |
| Max. frequency at terminal 29, 32, 33 | 5 kHz (open collector) |
| Min. frequency at terminal 29, 32, 33 | 4 Hz |
| Voltage level | See chapter 8.6.1 Digital Inputs |
| Maximum voltage on input | 28 V DC |
| Input resistance, R _i | Approx. 4 kΩ |
| Pulse input accuracy (0.1–1 kHz) | Max. error: 0.1% of full scale |
| Encoder input accuracy (1–11 kHz) | Max. error: 0.05% of full scale |

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

¹⁾ Pulse inputs are 29 and 33

²⁾ Encoder inputs: 32 = A, and 33 = B

Analog output

| | |
|---------------------------------------|--------------------------------|
| Number of programmable analog outputs | 1 |
| Terminal number | 42 |
| Current range at analog output | 0/4–20 mA |
| Max. load GND - analog output | 500 Ω |
| Accuracy on analog output | Max. error: 0.5% of full scale |
| Resolution on analog output | 12 bit |

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS-485 serial communication

| | |
|--------------------|----------------------------------|
| Terminal number | 68 (P,TX+, RX+), 69 (N,TX-, RX-) |
| Terminal number 61 | Common for terminals 68 and 69 |

The RS-485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output

| | |
|--|--------------------------------|
| Programmable digital/pulse outputs | 2 |
| Terminal number | 27, 29 ¹⁾ |
| Voltage level at digital/frequency output | 0–24 V |
| Max. output current (sink or source) | 40 mA |
| Max. load at frequency output | 1 kΩ |
| Max. capacitive load at frequency output | 10 nF |
| Minimum output frequency at frequency output | 0 Hz |
| Maximum output frequency at frequency output | 32 kHz |
| Accuracy of frequency output | Max. error: 0.1% of full scale |
| Resolution of frequency outputs | 12 bit |

¹⁾ Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output

| | |
|-----------------|---------------|
| Terminal number | 12, 13 |
| Output voltage | 24 V +1, -3 V |
| Max. load | 200 mA |

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs

| | |
|--|---|
| Programmable relay outputs | |
| Relay 01 Terminal number | 1-3 (break), 1-2 (make) |
| Max. terminal load (AC-1) ¹⁾ on 1-3 (NC), 1-2 (NO) (Resistive load) | 240 V AC, 2 A |
| Max. terminal load (AC-15) ¹⁾ (Inductive load @ cosφ 0.4) | 240 V AC, 0.2 A |
| Max. terminal load (DC-1) ¹⁾ on 1-2 (NO), 1-3 (NC) (Resistive load) | 60 V DC, 1 A |
| Max. terminal load (DC-13) ¹⁾ (Inductive load) | 24 V DC, 0.1 A |
| Relay 02 Terminal number | 4-6 (break), 4-5 (make) |
| Max. terminal load (AC-1) ¹⁾ on 4-5 (NO) (Resistive load) ²⁾³⁾ Overvoltage cat. II | 400 V AC, 2 A |
| Max. terminal load (AC-15) ¹⁾ on 4-5 (NO) (Inductive load @ cosφ 0.4) | 240 V AC, 0.2 A |
| Max. terminal load (DC-1) ¹⁾ on 4-5 (NO) (resistive load) | 80 V DC, 2 A |
| Max. terminal load (DC-13) ¹⁾ on 4-5 (NO) (inductive load) | 24 V DC, 0.1 A |
| Max. terminal load (AC-1) ¹⁾ on 4-6 (NC) (resistive load) | 240 V AC, 2 A |
| Max. terminal load (AC-15) ¹⁾ on 4-6 (NC) (Inductive load @ cosφ 0.4) | 240 V AC, 0.2 A |
| Max. terminal load (DC-1) ¹⁾ on 4-6 (NC) (resistive load) | 50 V DC, 2 A |
| Max. terminal load (DC-13) ¹⁾ on 4-6 (NC) (inductive load) | 24 V DC, 0.1 A |
| Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO) | 24 V DC 10 mA, 24 V AC 20 mA |
| Environment according to EN 60664-1 | Overvoltage category III/pollution degree 2 |

¹⁾ IEC 60947 part 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

²⁾ Overvoltage Category II

³⁾ UL applications 300 V AC 2A

Control card, 10 V DC output

| | |
|-----------------|--------------------|
| Terminal number | 50 |
| Output voltage | 10.5 V \pm 0.5 V |
| Max. load | 15 mA |

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics

| | |
|--|----------------------------------|
| Resolution of output frequency at 0–590 Hz | \pm 0.003 Hz |
| Repeat accuracy of <i>Precise start/stop</i> (terminals 18, 19) | $\leq \pm$ 0.1 ms |
| System response time (terminals 18, 19, 27, 29, 32, 33) | \leq 2 ms |
| Speed control range (open-loop) | 1:100 of synchronous speed |
| Speed control range (closed-loop) | 1:1000 of synchronous speed |
| Speed accuracy (open-loop) | 30–4000 rpm: error \pm 8 rpm |
| Speed accuracy (closed-loop), depending on resolution of feedback device | 0–6000 rpm: error \pm 0.15 rpm |

All control characteristics are based on a 4-pole asynchronous motor

Control card performance

| | |
|---------------|------|
| Scan interval | 1 ms |
|---------------|------|

Control card, USB serial communication

| | |
|--------------|--------------------------|
| USB standard | 1.1 (full speed) |
| USB plug | USB type B “device” plug |

Connection to PC is carried out via a standard host/device USB cable.

The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

The USB ground connection is not galvanically isolated from protection ground. Use only an isolated laptop as PC connection to the USB connector on the adjustable frequency drive.

8.7 Connection Tightening Torques

| Enclosure | Power (hp [kW]) | | | Torque (in-lb [Nm]) | | | |
|-----------|------------------|--------------------|--------------------|--|--|------------------------|--------------------------|
| | 200–240 V | 380–480 V | 525–600 V | Line power | Motor | Ground | Relay |
| A2 | 1.5–3 [1.1–2.2] | 1.5–5 [1.1–4.0] | | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| A3 | 4–5 [3.0–3.7] | 7.5–10 [5.5–7.5] | 1.5–10 [1.1–7.5] | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| A4 | 1.5–3 [1.1–2.2] | 1.5–5 [1.1–4.0] | | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| A5 | 1.5–5 [1.1–3.7] | 1.5–10 [1.1–7.5] | 1.5–10 [1.1–7.5] | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| B1 | 7.5–10 [5.5–7.5] | 15–20 [11–15] | 15–20 [11–15] | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| B2 | 15 [11] | 24 [18] 30 [22] | 24 [18] 30 [22] | 39.83 [4.5] 39.83 [4.5] | 39.83 [4.5] 39.83 [4.5] | 26.55 [3] 26.55 [3] | 5.31 [0.6] 5.31 [0.6] |
| B3 | 7.5–10 [5.5–7.5] | 15–20 [11–15] | 15–20 [11–15] | 15.93 [1.8] | 15.93 [1.8] | 26.55 [3] | 5.31 [0.6] |
| B4 | 15–20 [11–15] | 24–40 [18–30] | 24–40 [18–30] | 39.83 [4.5] | 39.83 [4.5] | 26.55 [3] | 5.31 [0.6] |
| C1 | 20–30 [15–22] | 40–60 [30–45] | 40–60 [30–45] | 88.51 [10] | 88.51 [10] | 26.55 [3] | 5.31 [0.6] |
| C2 | 40–50 [30–37] | 75–100 [55–75] | 75–100 [55–75] | 123.91/212.42 [14/24] ¹⁾ | 123.91/212.42 [14/24] ¹⁾ | 26.55 [3] | 5.31 [0.6] |
| C3 | 24–30 [18–22] | 50–60 [37–45] | 50–60 [37–45] | 88.51 [10] | 88.51 [10] | 26.55 [3] | 5.31 [0.6] |
| C4 | 40–50 [30–37] | 75–100 [55–75] | 75–100 [55–75] | 123.91/212.42 [14/24] ¹⁾ | 123.91/212.42 [14/24] ¹⁾ | 26.55 [3] | 5.31 [0.6] |

Table 8.7 Tightening of Terminals

¹⁾ For different cable dimensions x/y, where x \leq 4/0 AWG [95 mm²] and y \geq 4/0 AWG [95 mm²].

8.8 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection in case of component breakdown inside the adjustable frequency drive (first fault).

NOTICE!

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Recommendations

- Fuses of the type gG
- Circuit breakers of Moeller types. When using other circuit breaker types, ensure that the energy going into the adjustable frequency drive is equal to or lower than the energy provided by Moeller types.

If recommended fuses/circuit breakers are chosen, possible damages to the adjustable frequency drive will mainly be limited to damages inside the unit. For further information, see *Application Note Fuses and Circuit Breakers, MN90T*.

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), depending on the adjustable frequency drive voltage rating. With the proper fusing the adjustable frequency drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

8.8.1 CE Compliance

200–240 V

| Enclosure type | Power (hp [kW]) | Recommended fuse size | Recommended max. fuse size | Recommended circuit breaker (Moeller) | Max. trip level [A] |
|----------------|-------------------|---|--|---------------------------------------|---------------------|
| A2 | 1.5–3 [1.1–2.2] | gG-10 (1.5–2 [1.1–1.5]) gG-16 (3 [2.2]) | gG-25 | PKZM0-25 | 25 |
| A3 | 4–5 [3.0–3.7] | gG-16 (4 [3]) gG-20 (5 [3.7]) | gG-32 | PKZM0-25 | 25 |
| B3 | 7.5–15 [5.5–11] | gG-25 (7.5–10 [5.5–7.5]) gG-32 (15 [11]) | gG-63 | PKZM4-50 | 50 |
| B4 | 20–24 [15–18] | gG-50 (20 [15]) gG-63 (25 [18]) | gG-125 | NZMB1-A100 | 3.94 [100] |
| C3 | 30–40 [22–30] | gG-80 (30 [22]) aR-125 (40 [30]) | gG-150 (22) aR-160 (30) | NZMB2-A200 | 150 |
| C4 | 50–60 [37–45] | aR-160 (50 [37]) aR-200 (60 [45]) | aR-200 (50 [37]) aR-250 (60 [45]) | NZMB2-A250 | 250 |
| A4 | 1.5–3 [1.1–2.2] | gG-10 (1.5–2 [1.1–1.5]) gG-16 (3 [2.2]) | gG-32 | PKZM0-25 | 25 |
| A5 | 0.34–5 [0.25–3.7] | gG-10 (0.34–2 [0.25–1.5]) gG-16 (3–4 [2.2–3]) gG-20 (5 [3.7]) | gG-32 | PKZM0-25 | 25 |
| B1 | 7.5–15 [5.5–11] | gG-25 (7.5 [5.5]) gG-32 (10–15 [7.5–11]) | gG-80 | PKZM4-63 | 63 |
| B2 | 15 | gG-50 | gG-100 | NZMB1-A100 | 100 |
| C1 | 24–40 [18–30] | gG-63 (25 [18.5]) gG-80 (30 [22]) gG-100 (40 [30]) | gG-160 (25–30 [18.5–22]) aR-160 (40 [30]) | NZMB2-A200 | 160 |
| C2 | 50–60 [37–45] | aR-160 (50 [37]) aR-200 (60 [45]) | aR-200 (50 [37]) aR-250 (60 [45]) | NZMB2-A250 | 250 |

Table 8.8 200–240 V, Enclosure Types A, B and C

380–480 V

| Enclosure type | Power (hp [kW]) | Recommended fuse size | Recommended max. fuse size | Recommended circuit breaker (Moeller) | Max. trip level [A] |
|----------------|------------------|---|--------------------------------------|---------------------------------------|---------------------|
| A2 | 1.5–5 [1.1–4.0] | gG-10 (1.5–4 [1.1–3]) gG-16 (5 [4]) | gG-25 | PKZM0-25 | 25 |
| A3 | 7.5–10 [5.5–7.5] | gG-16 | gG-32 | PKZM0-25 | 25 |
| B3 | 15–24 [11–18] | gG-40 | gG-63 | PKZM4-50 | 50 |
| B4 | 30–50 [22–37] | gG-50 (30 [22]) gG-63 (40 [30]) gG-80 (50 [37]) | gG-125 | NZMB1-A100 | 3.94 [100] |
| C3 | 60–75 [45–55] | gG-100 (60 [45]) gG-160 (75 [55]) | gG-150 (60 [45]) gG-160 (75 [55]) | NZMB2-A200 | 150 |
| C4 | 100–125 [75–90] | aR-200 (100 [75]) aR-250 (125 [90]) | aR-250 | NZMB2-A250 | 250 |
| A4 | 1.5–5 [1.1–4] | gG-10 (1.5–4 [1.1–3]) gG-16 (5 [4]) | gG-32 | PKZM0-25 | 25 |
| A5 | 1.5–10 [1.1–7.5] | gG-10 (1.5–4 [1.1–3]) gG-16 (5–10 [4–7.5]) | gG-32 | PKZM0-25 | 25 |
| B1 | 15–25 [11–18.5] | gG-40 | gG-80 | PKZM4-63 | 63 |
| B2 | 30–40 [22–30] | gG-50 (30 [22]) gG-63 (40 [30]) | gG-100 | NZMB1-A100 | 100 |
| C1 | 50–75 [37–55] | gG-80 (50 [37]) gG-100 (60 [45]) gG-160 (75 [55]) | gG-160 | NZMB2-A200 | 160 |
| C2 | 100–125 [75–90] | aR-200 (100 [75]) aR-250 (125 [90]) | aR-250 | NZMB2-A250 | 250 |

Table 8.9 380–480 V, Enclosure Types A, B and C

525–600 V

| Enclosure type | Power (hp [kW]) | Recommended fuse size | Recommended max. fuse size | Recommended circuit breaker (Moeller) | Max. trip level [A] |
|----------------|------------------|---|--|---------------------------------------|---------------------|
| A3 | 7.5–10 [5.5–7.5] | gG-10 (7.5 [5.5]) gG-16 (10 [7.5]) | gG-32 | PKZM0-25 | 25 |
| B3 | 15–24 [11–18] | gG-25 (15 [11]) gG-32 (20–25 [15–18]) | gG-63 | PKZM4-50 | 50 |
| B4 | 30–50 [22–37] | gG-40 (30 [22]) gG-50 (40 [30]) gG-63 (50 [37]) | gG-125 | NZMB1-A100 | 100 |
| C3 | 60–75 [45–55] | gG-63 (60 [45]) gG-100 (75 [55]) | gG-150 | NZMB2-A200 | 150 |
| C4 | 100–125 [75–90] | aR-160 (100 [75]) aR-200 (125 [90]) | aR-250 | NZMB2-A250 | 250 |
| A5 | 1.5–10 [1.1–7.5] | gG-10 (1.5–7.5 [1.1–5.5]) gG-16 (10 [7.5]) | gG-32 | PKZM0-25 | 25 |
| B1 | 15–24 [11–18] | gG-25 (15 [11]) gG-32 (20 [15]) gG-40 (25 [18.5]) | gG-80 | PKZM4-63 | 63 |
| B2 | 30–40 [22–30] | gG-50 (30 [22]) gG-63 (40 [30]) | gG-100 | NZMB1-A100 | 100 |
| C1 | 50–75 [37–55] | gG-63 (50 [37]) gG-100 (60 [45]) aR-160 (75 [55]) | gG-160 (50–60 [37–45]) aR-250 (75 [55]) | NZMB2-A200 | 160 |
| C2 | 100–125 [75–90] | aR-200 (100–125 [75–90]) | aR-250 | NZMB2-A250 | 250 |

Table 8.10 525–600 V, Enclosure Types A, B and C

8.8.2 UL Compliance

1 x 200-240 V

| Power [kW] | Max prefuse size [A] | Bussmann JFHR2 | Recommended max. fuse | | | | | | | | | | |
|------------|----------------------|----------------|-----------------------|------------|------------|-------------|-------------|-------------|-------------|-----------------|-------------------|--------------------|------------------|
| | | | Bussmann RK1 | Bussmann J | Bussmann T | Bussmann CC | Bussmann CC | Bussmann CC | SIBA RK1 | Littel fuse RK1 | Ferraz-Shawmut CC | Ferraz-Shawmut RK1 | Ferraz-Shawmut J |
| 1.1 | 15 | FWX-15 | KTN-R15 | JKS-15 | JJN-15 | FNQ-R15 | KTK-R15 | LP-CC-15 | 5017906-016 | KLN-R15 | ATM-R15 | A2K-15R | HSJ15 |
| 1.5 | 20 | FWX-20 | KTN-R20 | JKS-20 | JJN-20 | FNQ-R20 | KTK-R20 | LP-CC-20 | 5017906-020 | KLN-R20 | ATM-R20 | A2K-20R | HSJ20 |
| 2.2 | 30* | FWX-30 | KTN-R30 | JKS-30 | JJN-30 | FNQ-R30 | KTK-R30 | LP-CC-30 | 5012406-032 | KLN-R30 | ATM-R30 | A2K-30R | HSJ30 |
| 3.0 | 35 | FWX-35 | KTN-R35 | JKS-35 | JJN-35 | | | | --- | KLN-R35 | --- | A2K-35R | HSJ35 |
| 3.7 | 50 | FWX-50 | KTN-R50 | JKS-50 | JJN-50 | | | | 5014006-050 | KLN-R50 | --- | A2K-50R | HSJ50 |
| 5.5 | 60** | FWX-60 | KTN-R60 | JKS-60 | JJN-60 | | | | 5014006-063 | KLN-R60 | --- | A2K-60R | HSJ60 |
| 7.5 | 80 | FWX-80 | KTN-R80 | JKS-80 | JJN-80 | | | | 5014006-080 | KLN-R80 | --- | A2K-80R | HSJ80 |
| 15 | 150 | FWX-150 | KTN-R150 | JKS-150 | JJN-150 | | | | 2028220-150 | KLN-R150 | | A2K-150R | HSJ150 |
| 22 | 200 | FWX-200 | KTN-R200 | JKS-200 | JJN-200 | | | | 2028220-200 | KLN-R200 | | A2K-200R | HSJ200 |

Table 8.11 1 x 200-240 V

* Siba allowed up to 32 A ; ** Siba allowed up to 63 A

3x200-240 V

| Power [kW] | Recommended max. fuse | | | | | |
|------------|---------------------------------|-----------------|-----------------|------------------|------------------|------------------|
| | Bussmann Type RK1 ¹⁾ | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann Type CC | Bussmann Type CC |
| 1.1 | KTN-R-10 | JKS-10 | JJN-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 |
| 1.5 | KTN-R-15 | JKS-15 | JJN-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 |
| 2.2 | KTN-R-20 | JKS-20 | JJN-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 |
| 3.0 | KTN-R-25 | JKS-25 | JJN-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 |
| 3.7 | KTN-R-30 | JKS-30 | JJN-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 |
| 5.5/7.5 | KTN-R-50 | KS-50 | JJN-50 | - | - | - |
| 11 | KTN-R-60 | JKS-60 | JJN-60 | - | - | - |
| 15 | KTN-R-80 | JKS-80 | JJN-80 | - | - | - |
| 18.5-22 | KTN-R-125 | JKS-125 | JJN-125 | - | - | - |
| 30 | KTN-R-150 | JKS-150 | JJN-150 | - | - | - |
| 37 | KTN-R-200 | JKS-200 | JJN-200 | - | - | - |
| 45 | KTN-R-250 | JKS-250 | JJN-250 | - | - | - |

Table 8.12 3x200-240 V, Enclosure Types A, B and C

| Power [kW] | Recommended max. fuse | | | | | | | |
|------------|-----------------------|----------------------|------------------------|---------------------------------------|-----------------------------------|-------------------|------------------------------------|------------------|
| | SIBA Type RK1 | Littel fuse Type RK1 | Ferraz-Shawmut Type CC | Ferraz-Shawmut Type RK1 ³⁾ | Bussmann Type JFHR2 ²⁾ | Littel fuse JFHR2 | Ferraz-Shawmut JFHR2 ⁴⁾ | Ferraz-Shawmut J |
| 1.1 | 5017906-010 | KLN-R-10 | ATM-R-10 | A2K-10-R | FWX-10 | - | - | HSJ-10 |
| 1.5 | 5017906-016 | KLN-R-15 | ATM-R-15 | A2K-15-R | FWX-15 | - | - | HSJ-15 |
| 2.2 | 5017906-020 | KLN-R-20 | ATM-R-20 | A2K-20-R | FWX-20 | - | - | HSJ-20 |
| 3.0 | 5017906-025 | KLN-R-25 | ATM-R-25 | A2K-25-R | FWX-25 | - | - | HSJ-25 |
| 3.7 | 5012406-032 | KLN-R-30 | ATM-R-30 | A2K-30-R | FWX-30 | - | - | HSJ-30 |
| 5.5/7.5 | 5014006-050 | KLN-R-50 | - | A2K-50-R | FWX-50 | - | - | HSJ-50 |
| 11 | 5014006-063 | KLN-R-60 | - | A2K-60-R | FWX-60 | - | - | HSJ-60 |
| 15 | 5014006-080 | KLN-R-80 | - | A2K-80-R | FWX-80 | - | - | HSJ-80 |
| 18.5-22 | 2028220-125 | KLN-R-125 | - | A2K-125-R | FWX-125 | - | - | HSJ-125 |
| 30 | 2028220-150 | KLN-R-150 | - | A2K-150-R | FWX-150 | L25S-150 | A25X-150 | HSJ-150 |
| 37 | 2028220-200 | KLN-R-200 | - | A2K-200-R | FWX-200 | L25S-200 | A25X-200 | HSJ-200 |
| 45 | 2028220-250 | KLN-R-250 | - | A2K-250-R | FWX-250 | L25S-250 | A25X-250 | HSJ-250 |

Table 8.13 3x200-240 V, Enclosure Types A, B and C

- ¹⁾ KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.
- ²⁾ FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.
- ³⁾ A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V frequency converters.
- ⁴⁾ A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V frequency converters.

3x380-480 V

| Power [kW] | Recommended max. fuse | | | | | |
|------------|-----------------------|-----------------|-----------------|------------------|------------------|------------------|
| | Bussmann Type RK1 | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann Type CC | Bussmann Type CC |
| 1.1 | KTS-R-6 | JKS-6 | JJS-6 | FNQ-R-6 | KTK-R-6 | LP-CC-6 |
| 1.5-2.2 | KTS-R-10 | JKS-10 | JJS-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 |
| 3 | KTS-R-15 | JKS-15 | JJS-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 |
| 4 | KTS-R-20 | JKS-20 | JJS-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 |
| 5.5 | KTS-R-25 | JKS-25 | JJS-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 |
| 7.5 | KTS-R-30 | JKS-30 | JJS-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 |
| 11/15 | KTS-R-40 | JKS-40 | JJS-40 | - | - | - |
| 18 | KTS-R-50 | JKS-50 | JJS-50 | - | - | - |
| 22 | KTS-R-60 | JKS-60 | JJS-60 | - | - | - |
| 30 | KTS-R-80 | JKS-80 | JJS-80 | - | - | - |
| 37 | KTS-R-100 | JKS-100 | JJS-100 | - | - | - |
| 45 | KTS-R-125 | JKS-125 | JJS-125 | - | - | - |
| 55 | KTS-R-150 | JKS-150 | JJS-150 | - | - | - |
| 75 | KTS-R-200 | JKS-200 | JJS-200 | - | - | - |
| 90 | KTS-R-250 | JKS-250 | JJS-250 | - | - | - |

Table 8.14 3x380-480 V, Enclosure Types A, B and C

| Power [kW] | Recommended max. fuse | | | | | | | |
|------------|-----------------------|----------------------|------------------------|-------------------------|----------------|------------------|------------------------------------|-------------------|
| | SIBA Type RK1 | Littel fuse Type RK1 | Ferraz-Shawmut Type CC | Ferraz-Shawmut Type RK1 | Bussmann JFHR2 | Ferraz-Shawmut J | Ferraz-Shawmut JFHR2 ¹⁾ | Littel fuse JFHR2 |
| 1.1-2.2 | 5017906-010 | KLS-R-10 | ATM-R-10 | A6K-10-R | FWH-10 | HSJ-10 | - | - |
| 3 | 5017906-016 | KLS-R-15 | ATM-R-15 | A6K-15-R | FWH-15 | HSJ-15 | - | - |
| 4 | 5017906-020 | KLS-R-20 | ATM-R-20 | A6K-20-R | FWH-20 | HSJ-20 | - | - |
| 5.5 | 5017906-025 | KLS-R-25 | ATM-R-25 | A6K-25-R | FWH-25 | HSJ-25 | - | - |
| 7.5 | 5012406-032 | KLS-R-30 | ATM-R-30 | A6K-30-R | FWH-30 | HSJ-30 | - | - |
| 11/15 | 5014006-040 | KLS-R-40 | - | A6K-40-R | FWH-40 | HSJ-40 | - | - |
| 18 | 5014006-050 | KLS-R-50 | - | A6K-50-R | FWH-50 | HSJ-50 | - | - |
| 22 | 5014006-063 | KLS-R-60 | - | A6K-60-R | FWH-60 | HSJ-60 | - | - |
| 30 | 2028220-100 | KLS-R-80 | - | A6K-80-R | FWH-80 | HSJ-80 | - | - |
| 37 | 2028220-125 | KLS-R-100 | - | A6K-100-R | FWH-100 | HSJ-100 | - | - |
| 45 | 2028220-125 | KLS-R-125 | - | A6K-125-R | FWH-125 | HSJ-125 | - | - |
| 55 | 2028220-160 | KLS-R-150 | - | A6K-150-R | FWH-150 | HSJ-150 | - | - |
| 75 | 2028220-200 | KLS-R-200 | - | A6K-200-R | FWH-200 | HSJ-200 | A50-P-225 | L50-S-225 |
| 90 | 2028220-250 | KLS-R-250 | - | A6K-250-R | FWH-250 | HSJ-250 | A50-P-250 | L50-S-250 |

Table 8.15 3x380-480 V, Enclosure Types A, B and C

¹⁾ Ferraz-Shawmut A50QS fuses may substitute A50P fuses.

3x525-600 V

| Power [kW] | Recommended max. fuse | | | | | | | | | |
|------------|-----------------------|-----------------|-----------------|------------------|------------------|------------------|---------------|----------------------|-------------------------|------------------|
| | Bussmann Type RK1 | Bussmann Type J | Bussmann Type T | Bussmann Type CC | Bussmann Type CC | Bussmann Type CC | SIBA Type RK1 | Littel fuse Type RK1 | Ferraz-Shawmut Type RK1 | Ferraz-Shawmut J |
| 1.1 | KTS-R-5 | JKS-5 | JJS-6 | FNQ-R-5 | KTK-R-5 | LP-CC-5 | 5017906-005 | KLS-R-005 | A6K-5-R | HSJ-6 |
| 1.5-2.2 | KTS-R-10 | JKS-10 | JJS-10 | FNQ-R-10 | KTK-R-10 | LP-CC-10 | 5017906-010 | KLS-R-010 | A6K-10-R | HSJ-10 |
| 3 | KTS-R15 | JKS-15 | JJS-15 | FNQ-R-15 | KTK-R-15 | LP-CC-15 | 5017906-016 | KLS-R-015 | A6K-15-R | HSJ-15 |
| 4 | KTS-R20 | JKS-20 | JJS-20 | FNQ-R-20 | KTK-R-20 | LP-CC-20 | 5017906-020 | KLS-R-020 | A6K-20-R | HSJ-20 |
| 5.5 | KTS-R-25 | JKS-25 | JJS-25 | FNQ-R-25 | KTK-R-25 | LP-CC-25 | 5017906-025 | KLS-R-025 | A6K-25-R | HSJ-25 |
| 7.5 | KTS-R-30 | JKS-30 | JJS-30 | FNQ-R-30 | KTK-R-30 | LP-CC-30 | 5017906-030 | KLS-R-030 | A6K-30-R | HSJ-30 |
| 11/15 | KTS-R-35 | JKS-35 | JJS-35 | - | - | - | 5014006-040 | KLS-R-035 | A6K-35-R | HSJ-35 |
| 18 | KTS-R-45 | JKS-45 | JJS-45 | - | - | - | 5014006-050 | KLS-R-045 | A6K-45-R | HSJ-45 |
| 22 | KTS-R-50 | JKS-50 | JJS-50 | - | - | - | 5014006-050 | KLS-R-050 | A6K-50-R | HSJ-50 |
| 30 | KTS-R-60 | JKS-60 | JJS-60 | - | - | - | 5014006-063 | KLS-R-060 | A6K-60-R | HSJ-60 |
| 37 | KTS-R-80 | JKS-80 | JJS-80 | - | - | - | 5014006-080 | KLS-R-075 | A6K-80-R | HSJ-80 |
| 45 | KTS-R-100 | JKS-100 | JJS-100 | - | - | - | 5014006-100 | KLS-R-100 | A6K-100-R | HSJ-100 |
| 55 | KTS-R-125 | JKS-125 | JJS-125 | - | - | - | 2028220-125 | KLS-R-125 | A6K-125-R | HSJ-125 |
| 75 | KTS-R-150 | JKS-150 | JJS-150 | - | - | - | 2028220-150 | KLS-R-150 | A6K-150-R | HSJ-150 |
| 90 | KTS-R-175 | JKS-175 | JJS-175 | - | - | - | 2028220-200 | KLS-R-175 | A6K-175-R | HSJ-175 |

Table 8.16 3x525-600 V, Enclosure Types A, B and C

8.9 Power Ratings, Weight and Dimensions

| Enclosure Type [kW] | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 |
|--|----------------|----------------|-------------|-------------|--------------|--------------|-------------|-------------|--------------|--------------|-------------|-------------|
| 200-240 V | 1.1-2.2 | 3.0-3.7 | 1.1-2.2 | 1.1-3.7 | 5.5-11 | 15 | 5.5-11 | 15-18.5 | 18.5-30 | 37-45 | 22-30 | 37-45 |
| 380-480 V | 1.1-4.0 | 5.5-7.5 | 1.1-4.0 | 1.1-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| 525-600 V | 1.1-7.5 | 1.1-7.5 | 1.1-7.5 | 1.1-7.5 | 11-18.5 | 11-30 | 11-18.5 | 22-37 | 37-55 | 37-90 | 45-55 | 75-90 |
| IP | 20 | 20 | 21 | 55/66 | 21/55/66 | 21/55/66 | 20 | 20 | 21/55/66 | 21/55/66 | 20 | 20 |
| NEMA | Chassis Type 1 | Chassis Type 1 | Type 1 | Type 12/4X | Type 1/12/4X | Type 1/12/4X | Chassis | Chassis | Type 1/12/4X | Type 1/12/4X | Chassis | Chassis |
| Height (in [mm]) | | | | | | | | | | | | |
| Enclosure | A* | 9.69 [246] | 14.65 [372] | 15.35 [390] | 18.89 [480] | 25.59 [650] | 13.78 [350] | 18.11 [460] | 26.77 [680] | 30.32 [770] | 19.29 [490] | 23.62 [600] |
| Height of backplate | A | 10.55 [268] | 14.76 [375] | 15.35 [390] | 18.89 [480] | 25.59 [650] | 15.77 [399] | 10.51 [520] | 26.77 [680] | 30.32 [770] | 21.65 [550] | 25.98 [660] |
| Height with decoupling plate for serial communication bus cables | A | 14.72 [374] | - | - | - | - | 16.5 [419] | 23.43 [595] | - | - | 24.8 [630] | 31.5 [800] |
| Distance between mounting holes | a | 10.12 [257] | 13.78 [350] | 15.79 [401] | 17.87 [454] | 25.57 [624] | 14.96 [380] | 19.49 [495] | 25.5 [648] | 29.1 [739] | 20.51 [521] | 24.84 [631] |
| Width (in [mm]) | | | | | | | | | | | | |
| Enclosure | B | 3.54 [90] | 5.12 [130] | 7.87 [200] | 9.53 [242] | 9.53 [242] | 6.5 [165] | 9.1 [231] | 12.93 [308] | 14.57 [370] | 12.93 [308] | 14.57 [370] |
| Width of backplate | B | 3.54 [90] | 5.12 [130] | 7.87 [200] | 9.53 [242] | 9.53 [242] | 6.5 [165] | 9.1 [231] | 12.93 [308] | 14.57 [370] | 12.93 [308] | 14.57 [370] |
| Width of backplate with one C option | B | 5.12 [130] | 6.69 [170] | 9.53 [242] | 9.53 [242] | 9.53 [242] | 8.07 [205] | 9.1 [231] | 12.93 [308] | 14.57 [370] | 12.93 [308] | 14.57 [370] |
| Distance between mounting holes | b | 2.76 [70] | 4.33 [110] | 6.73 [171] | 8.47 [215] | 8.27 [210] | 5.51 [140] | 7.87 [200] | 10.71 [272] | 13.15 [334] | 10.63 [270] | 13 [330] |
| Depth** (in [mm]) | | | | | | | | | | | | |
| Without option A/B | C | 8.07 [205] | 8.07 [205] | 6.89 [175] | 7.87 [200] | 10.24 [260] | 9.76 [248] | 9.53 [242] | 12.21 [310] | 13.19 [335] | 13.11 [333] | 13.11 [333] |
| With option A/B | C | 8.66 [220] | 8.66 [220] | 6.89 [175] | 7.87 [200] | 10.24 [260] | 10.32 [262] | 9.53 [242] | 12.21 [310] | 13.19 [335] | 13.11 [333] | 13.11 [333] |



| Enclosure Type [kW] | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 |
|-------------------------------|-------------|-------------|------------|------------|-----------|-----------|------------|------------|------------|------------|------------|------------|
| 200-240 V | 1.1-2.2 | 3.0-3.7 | 1.1-2.2 | 1.1-3.7 | 5.5-11 | 15 | 5.5-11 | 15-18.5 | 18.5-30 | 37-45 | 22-30 | 37-45 |
| 380-480 V | 1.1-4.0 | 5.5-7.5 | 1.1-4.0 | 1.1-7.5 | 11-18.5 | 22-30 | 11-18.5 | 22-37 | 37-55 | 75-90 | 45-55 | 75-90 |
| 525-600 V | | 1.1-7.5 | | 1.1-7.5 | 11-18.5 | 11-30 | 11-18.5 | 22-37 | 37-55 | 37-90 | 45-55 | 75-90 |
| Screw holes (in [mm]) | | | | | | | | | | | | |
| c | 0.315 [8.0] | 0.315 [8.0] | 0.32 [8.2] | 0.32 [8.2] | 0.47 [12] | 0.47 [12] | 0.315 [8] | - | 0.47 [12] | 0.47 [12] | - | - |
| d | 0.43 [11] | 0.43 [11] | 0.47 [12] | 0.47 [12] | 0.75 [19] | 0.75 [19] | 0.47 [12] | - | 0.75 [19] | 0.75 [19] | - | - |
| e | 0.22 [5.5] | 0.22 [5.5] | 0.26 [6.5] | 0.26 [6.5] | 0.35 [9] | 0.35 [9] | 0.27 [6.8] | 0.34 [8.5] | 0.35 [9.0] | 0.35 [9.0] | 0.34 [8.5] | 0.34 [8.5] |
| f | 0.35 [9] | 0.35 [9] | 0.24 [6] | 0.35 [9] | 0.35 [9] | 0.35 [9] | 0.31 [7.9] | 0.59 [15] | 0.39 [9.8] | 0.39 [9.8] | 0.67 [17] | 0.67 [17] |
| Max. weight (lbs [kg]) | 10.8 [4.9] | 14.6 [6.6] | 21.4 [9.7] | 31 [14] | 51 [23] | 59.6 [27] | 26.5 [12] | 52 [23.5] | 99.2 [45] | 143.3 [65] | 77.2 [35] | 110.3 [50] |

* See Figure 3.4 and Figure 3.5 for top and bottom mounting holes.
 ** Depth of enclosure will vary with different options installed.

Table 8.17 Power Ratings, Weight and Dimensions

9 Appendix

9.1 Symbols, Abbreviations and Conventions

| | |
|---------------|---|
| AC | Alternating Current |
| AEO | Automatic Energy Optimization |
| AWG | American Wire Gauge |
| AMA | Automatic Motor Adaptation |
| °C | Degrees Celsius |
| DC | Direct Current |
| EMC | Electro Magnetic Compatibility |
| ETR | Electronic Thermal Relay |
| FC | Adjustable Frequency Drive |
| LCP | Local Control Panel |
| MCT | Motion Control Tool |
| IP | Ingress Protection |
| $I_{M,N}$ | Nominal Motor Current |
| $f_{M,N}$ | Nominal Motor Frequency |
| $P_{M,N}$ | Nominal Motor Power |
| $U_{M,N}$ | Nominal Motor Voltage |
| PM Motor | Permanent Magnet Motor |
| PELV | Protective Extra Low Voltage |
| PCB | Printed Circuit Board |
| PWM | Pulse Width Modulated |
| I_{LIM} | Current Limit |
| I_{INV} | Rated Inverter Output Current |
| RPM | Revolutions Per Minute |
| Regen | Regenerative Terminals |
| n_s | Synchronous Motor Speed |
| T_{LIM} | Torque Limit |
| $I_{VLT,MAX}$ | The Maximum Output Current |
| $I_{VLT,N}$ | The Rated Output Current Supplied by the Adjustable Frequency Drive |

Table 9.1 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of figures.

Italicized text indicates

- cross reference
- link
- parameter name

9.2 Parameter Menu Structure

| 0-0* | Operation / Display | Motor Construction | Compressor Min. Speed for Trip [Hz] | Max Output Frequency | 5-68 | Pulse Output Max Freq #X30/6 |
|------|--------------------------------------|---|--|---|------|--------------------------------------|
| 0-0* | Basic Settings | | | | | I/O Options |
| 0-01 | Language | 1-10 VVCplus PM | 1-87 Motor Temperature | 4-19 Adj. Warnings | 5-8* | AHF Cap Reconnect Delay |
| 0-02 | Motor Speed Unit | 1-14 Damping Gain | 1-90 Motor Thermal Protection | 4-50 Warning Current Low | 5-80 | Bus Controlled |
| 0-03 | Regional Settings | 1-15 Low Speed Filter Time Const. | 1-91 Motor External Fan | 4-51 Warning Current High | 5-9* | Digital & Relay Bus Control |
| 0-04 | Operating State at Power-up | 1-16 High Speed Filter Time Const. | 1-93 Thermistor Source | 4-52 Warning Speed Low | 5-90 | Pulse Out #27 Bus Control |
| 0-05 | Local Mode Unit | 1-17 Voltage filter time const. | 2-** Brakes | 4-53 Warning Speed High | 5-93 | Pulse Out #29 Bus Control |
| 0-1* | Set-up Operations | Motor Data | 2-0* DC-Brake | 4-54 Warning Reference Low | 5-94 | Pulse Out #27 Timeout Preset |
| 0-10 | Active Set-up | 2-00 Motor Power [kW] | 2-00 DC Hold/Preheat Current | 4-55 Warning Reference High | 5-95 | Pulse Out #29 Timeout Preset |
| 0-11 | Programming Set-up | 2-01 Motor Power [HP] | 2-01 DC Brake Current | 4-56 Warning Feedback Low | 5-96 | Pulse Out #X30/6 Bus Control |
| 0-12 | This Set-up Linked to | 2-02 Motor Voltage | 2-02 DC Braking Time | 4-57 Warning Feedback High | 5-97 | Pulse Out #X30/6 Timeout Preset |
| 0-13 | Readout: Linked Set-ups | 2-03 Motor Frequency | 2-03 DC Brake Cut In Speed [RPM] | 4-58 Missing Motor Phase Function | 6-6* | Analog In/Out |
| 0-14 | Readout: Prog. Set-ups / Channel | 2-04 Motor Current | 2-04 DC Brake Cut In Speed [Hz] | 4-6* Speed Bypass | 6-0* | Analog I/O Mode |
| 0-2* | LCP Display | 2-06 Motor Nominal Speed | 2-06 Parking Current | 4-60 Bypass Speed From [RPM] | 6-00 | Live Zero Timeout Time |
| 0-20 | Display Line 1.1 Small | 2-07 Motor Cont. Rated Torque | 2-07 Parking Time | 4-61 Bypass Speed From [Hz] | 6-01 | Live Zero Timeout Function |
| 0-21 | Display Line 1.2 Small | 2-08 Motor Rotat. Check | 2-1* Brake Energy Funct. | 4-62 Bypass Speed To [RPM] | 6-02 | Fire Mode Live Zero Timeout Function |
| 0-22 | Display Line 1.3 Small | 2-09 Automatic Motor Adaptation (AMA) | 2-10 Brake Function | 4-63 Bypass Speed To [Hz] | | Function |
| 0-23 | Display Line 2 Large | 1-3* Adv. Motor Data | 2-16 AC brake Max. Current | 4-64 Semi-Auto Bypass Set-up | 6-1* | Analog Input 53 |
| 0-24 | Display Line 3 Large | 1-30 Stator Resistance (Rs) | 2-17 Over-voltage Control | 5-0* Digital I/O mode | 6-10 | Terminal 53 Low Voltage |
| 0-25 | My Personal Menu | 1-31 Rotor Resistance (Rr) | 3-0* Reference Limits | 5-00 Digital I/O Mode | 6-11 | Terminal 53 High Voltage |
| 0-30 | LCP Custom Readout | 1-35 Main Reactance (Xh) | 3-02 Minimum Reference | 5-01 Terminal 27 Mode | 6-12 | Terminal 53 Low Current |
| 0-31 | Custom Readout Min Value | 1-36 Iron Loss Resistance (Rfe) | 3-03 Maximum Reference | 5-02 Terminal 29 Mode | 6-13 | Terminal 53 High Current |
| 0-32 | Custom Readout Max Value | 1-37 d-axis Inductance (Ld) | 3-04 Reference Function | 5-1* Digital Inputs | 6-14 | Terminal 53 Low Ref./Feedb. Value |
| 0-37 | Display Text 1 | 1-40 Back EMF at 1000 RPM | 3-1* References | 5-10 Terminal 18 Digital Input | 6-15 | Terminal 53 High Ref./Feedb. Value |
| 0-38 | Display Text 2 | 1-46 Position Detection Gain | 3-10 Preset Reference | 5-11 Terminal 19 Digital Input | 6-16 | Terminal 53 Filter Time Constant |
| 0-39 | Display Text 3 | 1-50 Motor Magnetisation at Zero Speed | 3-11 Jog Speed [Hz] | 5-12 Terminal 27 Digital Input | 6-17 | Terminal 53 Live Zero |
| 0-4* | LCP keypad | 1-51 Min Speed Normal Magnetising [RPM] | 3-13 Reference Site | 5-13 Terminal 29 Digital Input | 6-2* | Analog Input 54 |
| 0-40 | [Hand on] Key on LCP | 1-52 Min Speed Normal Magnetising [Hz] | 3-14 Preset Relative Reference | 5-15 Terminal 33 Digital Input | 6-20 | Terminal 54 Low Voltage |
| 0-41 | [Off] Key on LCP | 1-59 Flystart Test Pulses Frequency | 3-15 Reference 1 Source | 5-16 Terminal 32 Digital Input | 6-21 | Terminal 54 High Voltage |
| 0-42 | [Auto on] Key on LCP | 1-6* Load Depen. Setting | 3-16 Reference 2 Source | 5-17 Terminal X30/2 Digital Input | 6-22 | Terminal 54 Low Current |
| 0-43 | [Reset] Key on LCP | 1-60 Low Speed Load Compensation | 3-17 Reference 3 Source | 5-18 Terminal X30/3 Digital Input | 6-23 | Terminal 54 High Current |
| 0-5* | Copy/Save | 1-61 High Speed Load Compensation | 3-19 Jog Speed [RPM] | 5-18 Terminal X30/4 Digital Input | 6-24 | Terminal 54 Low Ref./Feedb. Value |
| 0-50 | LCP Copy | 1-62 Slip Compensation | 3-4* Ramp 1 | 5-19 Terminal 37 Safe Stop | 6-25 | Terminal 54 High Ref./Feedb. Value |
| 0-51 | Set-up Copy | 1-63 Slip Compensation Time Constant | 3-41 Ramp 1 Ramp Up Time | 5-3* Digital Outputs | 6-26 | Terminal 54 Filter Time Constant |
| 0-6* | Password | 1-64 Resonance Dampening | 3-42 Ramp 1 Ramp Down Time | 5-30 Terminal 27 Digital Output | 6-27 | Terminal 54 Live Zero |
| 0-61 | Access to Main Menu w/o Password | 1-65 Resonance Dampening Time | 3-51 Ramp 2 Ramp Up Time | 5-31 Terminal 29 Digital Output | 6-30 | Analog Input X30/11 |
| 0-65 | Access to Personal Menu w/o Password | 1-66 Min. Current at Low Speed | 3-52 Ramp 2 Ramp Down Time | 5-32 Term X30/6 Digi Out (MCB 101) | 6-30 | Terminal X30/11 Low Voltage |
| 0-66 | Password | 1-67 Start Adjustments | 3-8* Other Ramps | 5-33 Term X30/7 Digi Out (MCB 101) | 6-31 | Terminal X30/11 High Voltage |
| 0-67 | Bus Password Access | 1-70 PM Start Mode | 3-80 Jog Ramp Time | 5-4* Relays | 6-34 | Term. X30/11 Low Ref./Feedb. Value |
| 0-70 | Set Date and Time | 1-71 Start Delay | 3-81 Quick Stop Ramp Time | 5-40 Function Relay | 6-35 | Term. X30/11 High Ref./Feedb. Value |
| 0-71 | Date Format | 1-72 Start Function | 3-82 Starting Ramp Up Time | 5-41 On Delay, Relay | 6-36 | Term. X30/11 Filter Time Constant |
| 0-72 | Time Format | 1-73 Flying Start | 3-9* Digital Pot.Meter | 5-42 Off Delay, Relay | 6-37 | Term. X30/11 Live Zero |
| 0-74 | DST/Summertime | 1-74 Start Speed [RPM] | 3-90 Step Size | 5-50 Term. 29 Low Frequency | 6-4* | Analog Input X30/12 |
| 0-76 | DST/Summertime Start | 1-75 Start Speed [Hz] | 3-91 Ramp Time | 5-51 Term. 29 High Frequency | 6-40 | Terminal X30/12 Low Voltage |
| 0-77 | DST/Summertime End | 1-76 Start Current | 3-92 Power Restore | 5-52 Term. 29 Low Ref./Feedb. Value | 6-41 | Terminal X30/12 High Voltage |
| 0-79 | Clock Fault | 1-77 Compressor Start Max Speed [RPM] | 3-93 Maximum Limit | 5-53 Term. 29 High Ref./Feedb. Value | 6-45 | Term. X30/12 Low Ref./Feedb. Value |
| 0-81 | Working Days | 1-78 Compressor Start Max Speed [Hz] | 3-94 Minimum Limit | 5-54 Pulse Filter Time Constant #29 | 6-46 | Term. X30/12 High Ref./Feedb. Value |
| 0-82 | Additional Working Days | 1-79 Compressor Start Max Time to Trip | 3-95 Ramp Delay | 5-55 Term. 33 Low Frequency | 6-47 | Term. X30/12 Filter Time Constant |
| 0-83 | Additional Non-Working Days | 1-8* Stop Adjustments | 4-** Limits / Warnings | 5-56 Term. 33 High Frequency | 6-5* | Analog Output 42 |
| 0-89 | Date and Time Readout | 1-80 Function at Stop | 4-1* Motor Limits | 5-57 Term. 33 Low Ref./Feedb. Value | 6-50 | Terminal 42 Output |
| 1-0* | General Settings | 1-81 Min Speed for Function at Stop [RPM] | 4-10 Motor Speed Direction | 5-58 Term. 33 High Ref./Feedb. Value | 6-51 | Terminal 42 Output Min Scale |
| 1-00 | Configuration Mode | 1-82 Compressor Min. Speed for Trip [RPM] | 4-11 Motor Speed Low Limit [RPM] | 5-59 Pulse Filter Time Constant #33 | 6-52 | Terminal 42 Output Max Scale |
| 1-03 | Torque Characteristics | 1-86 Compressor Min. Speed for Trip [RPM] | 4-12 Motor Speed High Limit [RPM] | 5-60 Terminal 27 Pulse Output Variable | 6-53 | Terminal 42 Output Bus Control |
| 1-1* | Motor Selection | | 4-13 Motor Speed High Limit [Hz] | 5-62 Pulse Output Max Freq #27 | 6-54 | Terminal 42 Output Timeout Preset |
| | | | 4-14 Torque Limit Motor Mode | 5-63 Pulse Output Max Freq #29 | 6-6* | Analog Output X30/8 |
| | | | 4-17 Torque Limit Generator Mode [RPM] | 5-65 Pulse Output Max Freq #29 | 6-60 | Terminal X30/8 Output |
| | | | 4-18 Current Limit | 5-66 Terminal X30/6 Pulse Output Variable | 6-61 | Terminal X30/8 Min. Scale |
| | | | | | 6-62 | Terminal X30/8 Max. Scale |

| | | | | | | | | | |
|-----------------------|-----------------------------------|----------------------------------|-------------------------------------|---|-----------------------------------|-------------------------------------|----------------------------|---------------------------|-----------------------|
| 6-63 | Terminal X30/8 Output Bus Control | 13-10 | Comparator Operand | 15-06 | Reset kWh Counter | 16-02 | Reference [%] | 16-9* | Diagnosis Readouts |
| 6-64 | Terminal X30/8 Output Timeout | 13-11 | Comparator Operator | 15-07 | Reset Running Hours Counter | 16-03 | Status Actual | 16-90 | Alarm Word |
| | Preset | 13-12 | Comparator Value | 15-08 | Number of Starts | 16-05 | Main Actual Value [%] | 16-91 | Alarm Word 2 |
| | 8-** Comm. and Options | 13-2* Timers | | 15-1* Data Log Settings | | 16-09 Custom Readout | | 16-92 Warning Word | |
| 8-0* | General Settings | 13-20 | SL Controller Timer | 15-10 | Logging Source | 16-1* Motor Status | | 16-93 | Warning Word 2 |
| 8-01 | Control Site | 13-40 | Logic Rule Boolean 1 | 15-11 | Logging Interval | 16-10 | Power [kW] | 16-94 | Ext. Status Word |
| 8-02 | Control Source | 13-40 | Logic Rule Boolean 1 | 15-12 | Trigger Event | 16-11 | Power [hp] | 16-95 | Ext. Status Word 2 |
| 8-03 | Control Timeout Time | 13-41 | Logic Rule Operator 1 | 15-13 | Logging Mode | 16-12 | Motor Voltage | 16-96 | Maintenance Word |
| 8-04 | Control Timeout Function | 13-42 | Logic Rule Boolean 2 | 15-14 | Samples Before Trigger | 16-13 | Frequency | | |
| 8-05 | End-of-Timeout Function | 13-43 | Logic Rule Operator 2 | 15-2* Historic Log | | 16-14 | Motor current | | |
| 8-06 | Reset Control Timeout | 13-44 | Logic Rule Boolean 3 | 15-20 | Historic Log: Event | 16-15 | Frequency [%] | | |
| 8-07 | Diagnosis Trigger | 13-5* | States | 15-21 | Historic Log: Value | 16-16 | Torque [Nm] | | |
| 8-1* | Control Settings | 13-51 | SL Controller Event | 15-22 | Historic Log: Time | 16-17 | Speed [RPM] | | |
| 8-10 | Control Profile | 13-52 | SL Controller Action | 15-23 | Historic log: Date and Time | 16-18 | Motor Thermal | | |
| 8-13 | Configurable Status Word STW | 14-** Special Function | | 15-3* Alarm Log | | 16-22 | Torque [%] | | |
| 8-3* | FC Port Settings | 14-0* | Inverter Switching | 15-30 | Alarm Log: Error Code | 16-3* Drive Status | | 18-30 | Analog Input X42/1 |
| 8-30 | Protocol | 14-00 | Switching Pattern | 15-31 | Alarm Log: Value | 16-30 | DC Link Voltage | 18-31 | Analog Input X42/3 |
| 8-31 | Address | 14-01 | Switching Frequency | 15-32 | Alarm Log: Time | 16-32 | Brake Energy /s | 18-32 | Analog Input X42/5 |
| 8-32 | Baud Rate | 14-03 | Overmodulation | 15-33 | Alarm Log: Date and Time | 16-33 | Brake Energy /2 min | 18-33 | Analog Out X42/7 [V] |
| 8-33 | Parity / Stop Bits | 14-04 | PWM Random | 15-34 | Alarm Log: Status | 16-34 | Heatsink Temp. | 18-34 | Analog Out X42/9 [V] |
| 8-35 | Minimum Response Delay | 14-1* | Mains On/Off | 15-35 | Alarm Log: Alarm Text | 16-35 | Inverter Thermal | 18-35 | Analog Out X42/11 [V] |
| 8-36 | Maximum Response Delay | 14-12 | Function at Mains Imbalance | 15-4* Drive Identification | | 16-36 | Inv. Norm. Current | | |
| 8-37 | Maximum Inter-Char Delay | 14-2* Reset Functions | | 15-40 | FC Type | 16-37 | Inv. Max. Current | | |
| 8-4* | Adv. Protocol Set. | 14-20 | Reset Mode | 15-41 | Power Section | 16-38 | SL Controller State | | |
| 8-40 | Telegram Selection | 14-21 | Automatic Restart Time | 15-42 | Voltage | 16-39 | Control Card Temp. | | |
| 8-45 | BTM Transaction Command | 14-22 | Operation Mode | 15-43 | Software Version | 16-40 | Logging Buffer Full | | |
| 8-46 | BTM Transaction Status | 14-23 | Typecode Setting | 15-44 | Ordered Typecode String | 16-41 | LCP Bottom Statusline | | |
| 8-47 | BTM Transaction | 14-25 | Trip Delay at Torque Limit | 15-45 | Actual Typecode String | 16-49 | Current Fault Source | | |
| 8-5* | Digital/Bus | 14-26 | Trip Delay at Inverter Fault | 15-46 | Frequency Converter Ordering No | 16-5* Ref. & Feeds. | | | |
| 8-50 | Coasting Select | 14-28 | Production Settings | 15-47 | Power Card Ordering No | 16-50 | External Reference | | |
| 8-52 | DC Brake Select | 14-29 | Service Code | 15-48 | LCP Id No | 16-52 | Feedback[Unit] | | |
| 8-53 | Start Select | 14-3* Current Limit Ctrl. | | 15-49 | SW ID Control Card | 16-53 | Digi Pot Reference | | |
| 8-54 | Reversing Select | 14-30 | Current Lim Ctrl, Proportional Gain | 15-50 | SW ID Power Card | 16-54 | Feedback 2 [Unit] | | |
| 8-55 | Set-up Select | 14-31 | Current Lim Ctrl, Integration Time | 15-51 | Frequency Converter Serial Number | 16-55 | Feedback 3 [Unit] | | |
| 8-56 | Preset Reference Select | 14-32 | Current Lim Ctrl, Filter Time | 15-53 | Power Card Serial Number | 16-56 | Feedback 3 [Unit] | | |
| 8-8* | FC Port Diagnostics | 14-4* Energy Optimising | | 15-6* Option Ident | | 16-6* Inputs & Outputs | | | |
| 8-80 | Bus Message Count | 14-40 | VT Level | 15-60 | Option Mounted | 16-60 | Digital Input | | |
| 8-81 | Bus Error Count | 14-41 | AEO Minimum Magnetisation | 15-61 | Option SW Version | 16-61 | Terminal 53 Switch Setting | | |
| 8-82 | Slave Message Count | 14-42 | Minimum AEO Frequency | 15-62 | Option Ordering No | 16-62 | Analog Input 53 | | |
| 8-83 | Slave Error Count | 14-43 | Motor Cosphi | 15-63 | Option Serial No | 16-63 | Terminal 54 Switch Setting | | |
| 8-9* | Bus Jog / Feedback | 14-5* Environment | | 15-70 | Option in Slot A | 16-64 | Analog Input 54 | | |
| 8-94 | Bus Feedback 1 | 14-50 | RFI Filter | 15-71 | Slot A Option SW Version | 16-65 | Analog Output 42 [mA] | | |
| 8-95 | Bus Feedback 2 | 14-51 | DC Link Compensation | 15-72 | Option in Slot B | 16-66 | Digital Output [bin] | | |
| 8-96 | Bus Feedback 3 | 14-52 | Fan Control | 15-73 | Slot B Option SW Version | 16-67 | Pulse Input #29 [Hz] | | |
| | | 14-53 | Fan Monitor | 15-74 | Option in Slot C0/E0 | 16-68 | Pulse Input #33 [Hz] | | |
| | | 14-55 | Output Filter | 15-75 | Slot C0/E0 Option SW Version | 16-69 | Pulse Output #27 [Hz] | | |
| | | 14-59 | Actual Number of Inverter Units | 15-76 | Option in Slot C1/E1 | 16-70 | Pulse Output #29 [Hz] | | |
| 11-** LonWorks | | 14-6* Auto Derate | | 15-77 Slot C1/E1 Option SW Version | | 16-71 | Relay Output [bin] | | |
| 11-21 | Store Data Values | 14-60 | Function at Over Temperature | 15-8* Operating Data II | | 16-72 | Counter A | | |
| 11-90 | VLT Network Address | 14-60 | Function at Inverter Overload | 15-80 | Fan Running Hours | 16-73 | Counter B | | |
| 11-91 | AK Service Pin | 14-61 | Function at Inverter Overload | 15-81 | Preset Fan Running Hours | 16-75 | Analog In X30/11 | | |
| 11-98 | Alarm Text | 14-62 | Inv. Overload Derate Current | 15-9* Parameter Info | | 16-76 | Analog In X30/12 | | |
| 11-99 | Alarm Status | 15-** Drive Information | | 15-92 | Defined Parameters | 16-77 | Analog Out X30/8 [mA] | | |
| | | 15-0* Operating Data | | 15-93 | Modified Parameters | 16-8* Fieldbus & FC Port | | | |
| | | 15-00 | Operating hours | 15-99 | Parameter Metadata | 16-80 | Fieldbus CTW 1 | | |
| 13-0* | SLC Settings | 15-01 | Running Hours | 16-** Data Readouts | | 16-82 | Fieldbus REF 1 | | |
| 13-01 | Start Event | 15-02 | kWh Counter | 16-0* | General Status | 16-84 | Comm. Option STW | | |
| 13-02 | Stop Event | 15-03 | Power Up's | 16-01 | Reference [Unit] | 16-85 | FC Port CTW 1 | | |
| 13-03 | Reset SLC | 15-04 | Over Temp's | | | 16-86 | FC Port REF 1 | | |
| 13-1* | Comparators | 15-05 | Over Volts | | | | | | |

| | | | | | | | | | |
|-----------------------------|-------------------------------|-------|-----------------------------------|--------|---------------------------------|-------|------------------------------------|-------|--------------------------------------|
| 20-84 | On Reference Bandwidth | 21-61 | Ext. 3 Proportional Gain | 23-22 | Time-based Functions | 25-44 | Staging Speed [RPM] | 26-63 | Terminal X42/11 Bus Control |
| 20-9* PID Controller | | 21-62 | Ext. 3 Integral Time | 23-20* | Timed Actions | 25-45 | Staging Speed [Hz] | 26-64 | Terminal X42/11 Timeout Preset |
| 20-93 | PID Anti-Windup | 21-63 | Ext. 3 Differentiation Time | 23-00 | ON Time | 25-46 | Destaging Speed [RPM] | 28-2* | Compressor Functions |
| 20-94 | PID Proportional Gain | 21-64 | Ext. 3 Dif. Gain Limit | 23-01 | ON Action | 25-47 | Destaging Speed [Hz] | 28-1* | Oil Return Management |
| 20-95 | PID Integral Time | 22-2* | Appl. Functions | 23-02 | OFF Time | 25-8* | Status | 28-10 | Oil Return Management |
| 20-96 | PID Differentiation Time | 22-0* | Miscellaneous | 23-03 | OFF Action | 25-80 | Pack Status | 28-11 | Low Speed Running Time |
| 21-1* | Ext. Closed Loop | 22-00 | External Interlock Delay | 23-04 | Occurrence | 25-81 | Compressor Status | 28-12 | Fixed Boost Interval |
| 21-0* | Ext. CL Autotuning | 22-2* | No-Flow Detection | 23-1* | Maintenance | 25-82 | Lead Compressor | 28-13 | Boost Duration |
| 21-00 | Closed Loop Type | 22-20 | Low Power Auto Set-up | 23-10 | Maintenance Item | 25-83 | Relay Status | 28-2* | Discharge Temperature Monitor |
| 21-01 | PID Performance | 22-21 | Low Power Detection | 23-11 | Maintenance Action | 25-84 | Compressor ON Time | 28-20 | Temperature Source |
| 21-02 | PID Output Change | 22-22 | Low Speed Detection | 23-12 | Maintenance Time Base | 25-85 | Relay ON Time | 28-21 | Temperature Unit |
| 21-03 | Minimum Feedback Level | 22-23 | No-Flow Function | 23-13 | Maintenance Time Interval | 25-86 | Reset Relay Counters | 28-24 | Warning Level |
| 21-04 | Maximum Feedback Level | 22-24 | No-Flow Delay | 23-14 | Maintenance Date and Time | 25-87 | Inverse Interlock | 28-25 | Warning Action |
| 21-09 | PID Autotuning | 22-26 | Dry Pump Function | 23-1* | Maintenance Reset | 25-88 | Pack capacity [%] | 28-26 | Emergency Level |
| 21-1* | Ext. CL 1 Ref./Fb. | 22-27 | Dry Pump Delay | 23-15 | Reset Maintenance Word | 25-9* | Service | 28-27 | Discharge Temperature |
| 21-10 | Ext. 1 Ref./Feedback Unit | 22-3* | No-Flow Power Tuning | 23-16 | Reset Maintenance Text | 25-90 | Compressor Interlock | 28-7* | Day/Night Settings |
| 21-11 | Ext. 1 Minimum Reference | 22-30 | No-Flow Power | 23-5* | Energy Log | 25-91 | Manual Alternation | 28-71 | Day/Night Bus Indicator |
| 21-12 | Ext. 1 Maximum Reference | 22-31 | Power Correction Factor | 23-50 | Energy Log Resolution | 26-0* | Analog I/O Option | 28-72 | Enable Day/Night Via Bus |
| 21-13 | Ext. 1 Reference Source | 22-32 | Low Speed [RPM] | 23-51 | Period Start | 26-0* | Analog I/O Mode | 28-73 | Night Setback |
| 21-14 | Ext. 1 Feedback Source | 22-33 | Low Speed [Hz] | 23-53 | Energy Log | 26-00 | Terminal X42/1 Mode | 28-74 | Night Speed Drop [RPM] |
| 21-15 | Ext. 1 Setpoint | 22-34 | Low Speed Power [kW] | 23-54 | Reset Energy Log | 26-01 | Terminal X42/3 Mode | 28-75 | Night Speed Drop Override |
| 21-17 | Ext. 1 Reference [Unit] | 22-35 | Low Speed Power [HP] | 23-6* | Trending | 26-02 | Terminal X42/5 Mode | 28-76 | Night Speed Drop [Hz] |
| 21-18 | Ext. 1 Feedback [Unit] | 22-36 | High Speed [Hz] | 23-60 | Trend Variable | 26-1* | Analog Input X42/1 | 28-8* | P0 Optimization |
| 21-19 | Ext. 1 Output [%] | 22-37 | High Speed Power [kW] | 23-61 | Continuous Bin Data | 26-10 | Terminal X42/1 Low Voltage | 28-81 | dP0 Offset |
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